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To determine the potential for Brunei Darussalam Maura container terminal to serve as a transhipment hub for the Brunei, Indonesia, Malaysia and the Philippines EAST ASEAN growth area (BIMP-EAGA) region

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TO DETERMINE THE POTENTIAL FOR BRUNEI DARUSSALAM MUARA CONTAINER TERMINAL TO SERVE AS A TRANSHIPMENT HUB FOR THE BRUNEI, INDONESIA, MALAYSIA AND THE PHILIPPINES EAST ASEAN GROWTH AREA (BIMP-EAGA) REGION

By

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BRUNEI DARUSSALAM

A dissertation submitted to the World Maritime University in partial fulfillment of the requirements for the award of the degree of

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(PORT MANAGEMENT)

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DECLARATION

I certify that all the material in this dissertation that is not my own work has been identified, and no material is included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my own personal views, and are not necessarily endorsed by the University.

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Abstract

Title of Dissertation: **To determine the potential for Brunei Darussalam Muara Container Terminal to serve as a transhipment hub for the Brunei, Indonesia, Malaysia and Philippines EAST Growth Area (BIMP-EAGA)**

Degree: MSc

This dissertation is an evaluation of the BIMP-EAGA region, with particular emphasis on Muara Container Terminal and its prospects for serving the region, including as a container transhipment hub port.

Various concepts and theories that have a bearing on the objectives are explored in order to give a full understanding of whether Muara Container is suitable or possesss these factors knowing that the final objectives of the dissertation is to investigate the possibility for Brunei Darussalam to become a transhipment hub for the BIMP-EAGA region. To become a transhipment port would place MCT in a competition situation within Asian market. Knowing what is relevant for the Asian market in terms of main trend of shipping services and competing ports within the region would further lead MCT to gain a competitive advantage.

The current situation and future development of MCT were analyzed in order to provide a detailed overview of MCT's position in the market in comparison to other competing terminals in the region. The analyses and interpretation converge on the indicators of port performance, such as berth throughput, berth occupancy ratio, turn around time, waiting time, service time and productivity rate. In order to assess MCT potential as a future transhipment hub the potential future demand and their implications in terms of port investment were estimated.

The final chapter provides a synthesis of the evaluation. This chapter highlights the assessment of competition in the region. It also highlights the market potential for BIMP-EAGA considering MCT. It identifies issues that impact container growth in MCT. It addresses and emphasizes the final objectives of the dissertation. Amongst the key element which determines the feasibility of transhipment is the economics of shipping (transhipment) discussed in this chapter.

Keywords: Transhipment, economics of shipping, port competition, economies of scale, cargo base.

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LIST OF ABBREVIATIONS

AHP	Analytic Hierarchy Process
AFTA	Aean free trade area
ASEAN	Association of South East Asian Nation
BOR	Berth occupancy ratio
BIMP EAGA	Brunei Indonesia Malaysia Philippines East Growth Area
BEDB	Brunei Darussalam economic development board
CRS	Constant return-to-scale
DEA	Data envelopment analysis
DMU	Decision making unit
FMCDM	Fuzzy Multiple Criteria Decision Making Method
GDP	Growth domestic product
HHI	Herfindahl hirschman index
HI	Herfindahl index
KPI	Key port performance indicator
MCT	Muara container terminal
PTP	Port of Tanjung Pelepas
ST	Service time
TEU	Twenty equivalent unit
VRS	Variable return-to-scale

CHAPTER ONE

INTRODUCTION

1.1 Background

As a result of the trend of increasing vessel sizes, container terminals need to keep pace with their growing expectations and requirements. There is also an increasing focus by carriers and shippers on the issue of service reliability, especially when existing terminals become congested and the ports are unable to accommodate larger vessels. Therefore, more and more new container terminals are built with the objectives of hub/transhipment port in mind in order to meet these new requirements. Muara Container Terminal (MCT) is strategically located to the north of Sarawak and to the south of Sabah. This means that it is well positioned to serve the developing economies of Brunei, Indonesia, Malaysia and East ASEAN Growth Area, which has a market of some 50 million people. The number of containers handled at MCT continues to grow with average year-on-year growth of over 10% in 2007, and this trend is expected to continue in 2008, with further growth of in excess of 10%. Although the full development of MCT is yet to be achieved (up to and including Phase III), the current level of capacity at the terminal remains sufficient to be able to meet the needs of regional container shipping lines and shippers both now and in the future. Indeed, MCT has facilities that are comparable to much larger ports currently handling a considerable number of containers.

Recognising the above, MCT aspires to serve as a transhipment hub port for the BIMP-EAGA region. In order to achieve that three objectives which were identified, will address the potential to become a transhipment hub port.

1.2 Thesis objectives

The objectives of this dissertation are:

(i). To identify issues, which impact container volume growth in Muara and possible steps to overcome them,

(ii). To analyse Muara Container Terminal's challenges and opportunities

(iii). To study the shipping economics and transhipment market potential for BIMP-EAGA

1.3 Research methodology

The methodology applied for this study is divided into four classifications. First, is the descriptive method of research/literature research by going through concepts and theories from various types of literature in order to have better understanding about the definition of load centres/transhipment port. Second, is statistical analysis based on primary port data from 2004 to 2007 specifically; this pertains to port key port indicator(KPI) waiting time in port, berth occupancy rate, port time and service time. Thirdly; is estimation of throughput using relationship of influential variables the method use single regression for calculation of data. Finally, Data Envelopment Analysis (DEA) technique is used to measure pure technical efficiency of port and benchmarking the performance of the terminal operators of the ports in the selected region.

1.4 Limitations of the study

The study focuses and is limited to the assessment of the performance level of MCT in terms of ship's time in port and berth indicator and does not consider machinery output indicators. The port competition assessment level and analysis are limited to the performance and competition of the container terminal defined in the BIMP-EAGA region (selected region of Indonesia, Malaysia and Philippines). Some ports do not provide data due to confidentiality. In DEA analysis it uses DEA approaches using cross-sectional data, which is data specific to period of time whereas panel data is widely used recently due to having several advantages but it possesses computational complexity. The author only managed to collect data from 2000 to 2003 for shipping services offered from/to MCT.

1.5 Thesis plan

The final aim is to become a transhipment hub for the BIMP-EAGA region. First the definitions of transhipment/load centres will be discussed because quite often they cause confusion to readers. The next step is to concentrate on literature, going through concepts and theories. In order to become a transhipment the main elements explaining the shipping lines to select the proper transhipment port need to be reviewed. The dissertation also discusses the East Asian market trend in shipping services as well as assessing the overall current trend of competing port in East Asian. To identify what is specific in the Brunei market in terms of shipping services and the present situation of Muara Container Terminal in regards to other competing port in the region. This would later make it possible to identify terminals that MCT could compete with and at the same time address the first objectives which are to identify issues that impact on container growth in Muara. MCT potential as a future transhipment port will be investigated in order to be able to look at the future potential. This will be done by carrying out an estimate of future throughput. Transhipment ports are competing with other ports within the region over the regional cargoes. In order to be competitive MCT needs to invest in berth planning. The key port performance indicators (KPI) were also investigated and it will help MCT to identify the level of productivity and efficiency at quayside areas in terms of ship's port time and berth indicators. The final chapter will address the third objective which is the potential for BIMP-EAGA.

CHAPTER TWO

THE SELECTION OF TRANSHIPMENT PORTS BY SHIPPING LINES

Various factors explain why shipping lines decide to call at a transhipment port. The objective of this chapter is to review these various factors owing that the final objective of the dissertation is to investigate the possibility for Brunei Darussalam to become a transhipment hub for the BIMP-EAGA region.

This section provides definitions of transhipment ports, the second section discusses the factors influencing the choice of hub and the third section presents studies aiming at giving a hierarchy amongst these various factors. In order to easily identify these factors later when comparing whether MCT is suitable and possesses these factors, it is therefore categorized into sub-headings:

(i). Carrier's point of view
(ii). Shipper's point of view
(iii). Terminal operator's point of view
(iv). Influence of technology- bigger ship
(v). Literature
(vi). Combination of the above

2.1 Definition of transhipment/hub ports

The definition of transhipment port is close to the definition of a hub. According to Daniel (2002) "the concept of hub port is based on the "hub and spoke system" which is a physical distribution system based on a 'hub' moving cargo to and between several 'spoke' (spokes are either smaller ports or land cargo distribution area)".

The term 'hub' is therefore similar to the centre of a hub and spoke structure usually found in network industries, such as transportation and telecommunications. The shipping line collects numerous cargos at a single concentrated point, where information is communicated between hub ports which attract transportation companies (Hormer & O'Kelly, 2001).

Another term used for transhipment is load centre. 'Load centre' refers to ports where container traffic is consolidated (Hayuth, 1981). Alderton (1999) states that a hub port is sometimes characterized as a load centre. However, there is a distinction between the two concepts. Cullinane, (2000) debated that a load centre is used to explain the carriers's choice of determining traffic routing rather than used to express port status. Given the strategic location of a hub port where there is a concentration of traffic it should be the choice location for load center for carriers (Woo & Wook, 2005).

Malchow, (2001) identified hub-port is a designated load centre which is similar for carriers, to hub airports for airlines. He further stated that carriers would employ larger vessels at the load centre to minimize the calls made by the vessels. Moreover, a hub port where there is a concentration of container traffic enables the carrier to intensify their services and explore economies of scale as presented in Foggin and Dicer, (1985).

A multiple hub port shipping system generalised in the late 1990's due to deconcentration of cargoes and feeder ports now developed a hub port from feedering to interline transhipment (Jung, 2007). Notteboom, (2004) stated that due to increase in cargo availability, carriers and alliances introduced in their liner services new end-to-end services and pendulumn services. Cargos from different trades are then feed to and from the hub port.

> This service pattern focuses on a hub and spokes system of ports that allows shipping lines to provide a global grid of east/west, north/south and regional services. The large ships on the east/west routes will call mainly at transhipment hubs where containers will be shifted to multi-layered feeder subsystems serving north/south, diagonal and regional routes (Notteboom, 2004 p. 95). See Figure 1 for illustration of load centre and transhipment port.

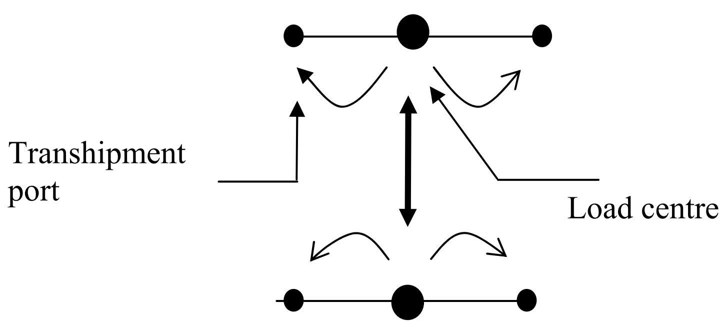


Figure 1 Load centre and transhipment port
Source: Ircha and Crook, (2008), Port management and analysis

2.2. Factors influencing the choice of direct versus transhipment services.

2.2.1 Factors determined by Carriers

The choice of operating services between transhipment (or Hubs and spokes system) and direct services is decided by the carriers (Baird, 2002a). Traditionally, maritime economists consider transhipment to be more expensive than direct call services for two main reasons: the extra feeder costs (feeder ship costs are much higher per TEU-mile) and the additional transhipment hub charges.

Baird's estimations (2005) on the deviation costs of operating a transhipment service in Orkney for Northern Europe was done considering the deviation distance from each major port in Northern Europe (Gothenburg, Hamburg, Bremerhaven, Rotterdam, Antwerp, Felixstowe, Le Harve) and the potential transhipment hub port in relation to the current ocean trade lane. Considering three different services scenario for Orkney to determine the mainline ship deviation distance, the author obtained substantial cost saving in favor of a pendulumn strings with a primary focus on serving established transhipment market via an optimal hub location (see Table 1).

Table: 1 - Mainline ship deviation distance in North Europe

Port transhipment via Deviation distance*	(nautical miles)
Orkney (end-to-end Eur–USEC)	53
Orkney (end-to-end Eur–Asia)	1438
Orkney (pendulum/RTW)	719
Gothenburg	1768
Hamburg	1386
Bremerhaven	1386
Rotterdam	880
Antwerp	890
Felixstowe	742
Le Havre	470

Source: Bairds, (2005) The economics of transhipment

* Deviation distance taken from Ushant Island (North West of France) to each port and back. Additional steaming distance incurred in multiport schedules is ignored. For Orkney end-to-end Eur–USEC service,the distance difference is that between Orkney–Halifax and Ushant–Halifax

Tongzon (2001) claimed that a hub port should have strategic location with one of the three characteristics; situated on shipping line route, situated in or near production centres, have natural draught, natural breakwater and big waterfront and landside development possibilities. Transhiped container will incur costs due to increase in transit time if not feeder timely. He further explained for fast connectivity hub ports employ single or common user terminals that eliminate inter terminal transfer (Lim, 1996). Lim (1996) explained for fast connectivity hub port employ single or common user terminal that eliminate inter terminal transfer. Tongzon (2001) considered in his studies factors such as geographical location being the nearest to the main shipping line routes, other elements within their control, such as productivity and service flexibility. Singapore government's effective policy approach to make sure PSA respond flexibility to rapidly changing market conditions are the key success factor of Singapore port.

Woo and Wook (2005) considered quality as an important element for the choice of carrier to consider a call in a hub port. They highlighted in their research three main components that are relevant for establishing a new framework of the quality of a hub port. The factors identified were:

(i). Studies of port selection criteria: a great deal of literature on this subject has been undertaken. Different dimensions have been reported and investigated. According to the researchers, the findings in this research to a larger extent, reflect a quality of a hub port.

(ii). Studies of load centre concept: the researchers considered that the fundamental characteristics of the load centre's are related to quality aspects of a hub port.

(iii). Studies on existing hub ports: the researchers states that some studies have been carried out based on existing hub ports such as the port of Hong Kong Cullinane (2000) and Singapore Tongzon (2001). According to the researcher, the success story reflected the quality of hub ports.

2.2.2 Factors determined by shippers

Tongzon (2001) states that shipping lines calling at hub ports do not only minimize cost but also get benefit from the high frequency of service, maximizing the utilization of slots of the mother vessels and having a wider choice of feeders. He also explained from the point of shippers that this system allows them a wider choice of shipping lines and times at more competitive rates.

2.2.3 Factors determined by the influence of technology- bigger ships

In fact there is also an influence of technology i.e the tendency of vessel size from the 1970s to 2000s increased considerably (see Figure 2).

Baird (2002b) explained for instance that the costs of making a port call being fixed and relatively small compared to the costs of transhipment, and considering that the number of container exchange is significant, a direct call might be preferable. Baird (2002c) also mentioned that direct calls at Benelux, German, and UK ports (i.e, multi itinerary), irrespective of ship size, would be far cheaper than a hub-and-spoke-based transhipment operation (Gilman, 1999). Stopford (1997) also stresses that the overall growth in container ships and hub ports will actually lead to slower transit times as compared to direct shipping by smaller carriers. He also believes that this growth will not necessarily lead to greater profitability. Ship-related costs are less than one-quarter of the total cost of services, and as ships grow in size and feeder services are used, economic benefits will shrink.

However, the industry, or at least the major carriers, appear to be moving in the opposite direction. Carriers are using more and more transhipment hubs in conjunction with the deployment of larger vessels (Baird, 2002). Baird (2002d) mentioned for instance that according to industry statistics, about 23% of all port container handling movements in 2001 would come from transhipment, compared to just 12% in 1980 (Damas, 2001).

In order to understand the reasons for such trend, a review of liner shipping strategies is necessary. The optimization of slot capacity for bigger capacity vessel shipping lines has led them to adopt two strategies during the last decade: (i). Consolidation (formation of alliance) (ii). and Transhipment.

The benefit of scale economies and cost savings of a hub and spoke system is the result of concentrating flow density on network linkages between hub locations (Hormer & O'Kelly, 2001). Cullinane et. al. (1999), modeled ship costs for the major east-west trades. The findings suggest that ship size of 8,0000 Teu achieved economies of scale for both Europe-Far East and trans-Pacific trades, and for ship sizes of between 5,000-6,000 Teu on the shorter trans-Atlantic trade. O'Mahony (1998) also states that major shipping lines choose a hub and spoke network system as it provides them a wider port coverage.

Wijnolst, (2000) stresses that transhipment service could only be competitive if there was a substantial percentage of containers transshipped (35-45%) in the main port for hinterland distribution. The study concluded that without this base cargo, the double terminal handling charges involved in feeder containers and the additional drayage would outweigh the benefits of using ultra-large container carriers. Unfortunately, no detailed cost breakdown was presented to justify his conclusion (Baird, 2002).

Various articles (Cullinane et al , (1999) and Stopford, 2001) have also highlighted that carriers call to transhipment hubs would provide higher transportation costs due to extra feeder as well as double handling cost. Baird, (2001) applied modeled costs analysis to determine ship costs, port costs and other costs associated with increase in ship size. He compared different size of container ship operating on alternative types of schedules ie. transhipment, feeder and multiport for service between Europe and Asia. The result of his study revealed significant cost savings by deploying a twice-weekly 4,000 teu hubportship service, although feedering and port handling incur additional costs.

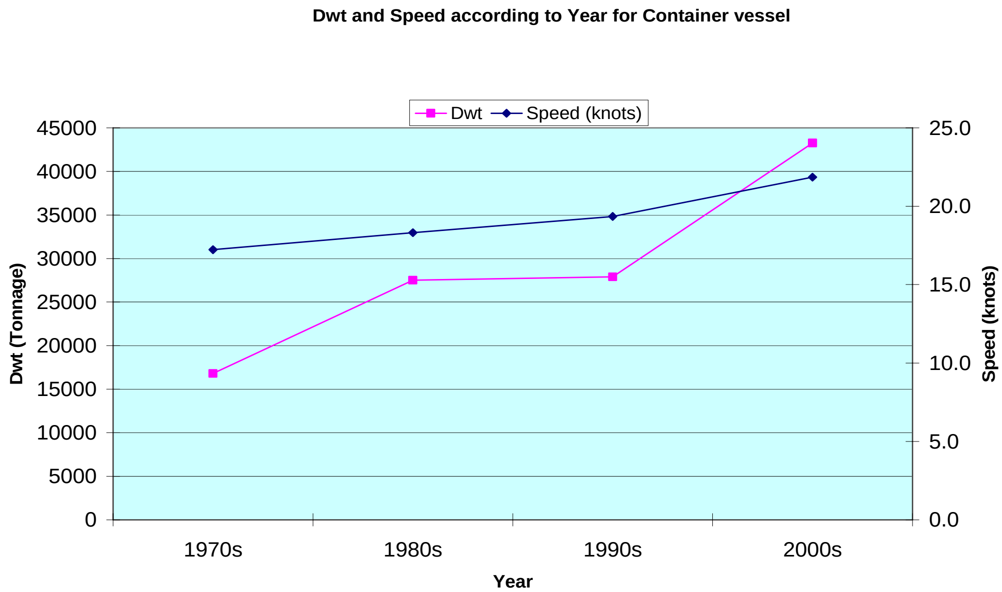


Figure 2 container vessel size 1970s to 2000's
Source: Author's own calculation data derived from Fairplay world shipping encyclopedia:ships

2.2.4 Factors determined by the operators

Frankel (2002) states that the objectives of transhipment are not just confined to total cost reduction, but also to improve just-in-time delivery of cargo, reduce in-transit inventory, and make the total origin-to-destination movement of containerized cargo more seamless. Transhipment is thus not just a logistics convenience measure, but also an opportunity to add value to the goods transshipped. According to the author, economics of transhipment should therefore also include all logistics along the supply chain comprised of value added activity costs and benefits contributed by transhipment activities. Magala and Sammons (2008) reach a similar conclusion in stressing that location and port efficiency in itself is not sufficient to attract cargo but rather lean towards a better quality of the supply chain. A study was also conducted in dealing with port selection in North America using supply chain as input parameters (Guy & Urli, 2006). Geographical location and intermodal connections are important elements for shipping lines in the configuration of their networks considering the port of Montreal has draught deficit.

2.3. Hierarchy amongst factors influencing the choice for transhipment port

2.3.1 Carrier's point of view

Lirn et al (2003) identified factors that determined the decision of carriers when selecting a port in the case of Taiwan. In this selection the researchers adopted the Analytic Hierarchy Process (AHP) to analyse transhipment-decision making. Four major criteria were used in the survey questionnaire along with 16 sub-criteria. The four major criteria selected based on expert opinion were:
(i). port basic physical characteristics, (ii). port geographical location, (iii). port management and (iv). carriers' cost perspective.

The analysis revealed that the most important criterion were divided into major and sub-criteria. The major criteria considered – (i). port geographical location and (ii). carrier's cost perspective are important factors for carriers to justify the call. For sub-criteria the carriers' chose carrier's loading/discharging cost as a determinant factor for carriers' perspective in selecting transhipment port in Taiwan.

Cullinane et al., (2005) suggest that due to changing market conditions and fierce competition between shipping lines, a cost cutting exercise has to be done in order to gain market shares. Moreover, mergers, takeovers and alliances amongst the larger shipping liner organizations have consolidated their domination of position in the market. The authors studied the redeployment of fleet and reconfiguration of shipping schedule prevailed (Ryoo & Thanopoulou, 1999). They further stated that relatively small ports will grow into large hub ports, and many of these container ports will be called by mainline vessel (Cullinane & Khanna, 1999).

Malchow and Kanafi, (2001) adopted data analysis to explain the selection of a port for four kinds of commodities exported from the U.S. Four factors are analysed - ocean distance, inland distance, sailing frequency and vessel capacity. The empirical study revealed that ocean distance and inland distance have significant impact on export port selection. Furthermore, vessel capacity and sailing frequency are less determinant. Malchow and Kanafi (2004) once again employed a discrete choice model to the cargo exported to evaluate the competitiveness of US export ports. They identified that the shipper's choice of ports was determined by the carrier's decision on providing services to that particular port. Port geographic location, port characteristics, and characteristics of vessel schedule as determinant factors for port selection, the geographic location was the most important criterion.

Chou (2007) presented the Fuzzy Multiple Criteria Decision Making Method (FMCDM) for solving the transhipment container port selection problem under fuzzy environment to select the best transhipment port in Taiwan. He applied canonical representation to the selection of transhipment container port. Canonical representation presented on three trapezoidal fuzzy numbers. This helps the decision maker of a shipping company to rank in orderly manner of all candidate transhipment container ports and then selection of the best one is made in this case Kaohsiung. This explains that determinant factors in selecting transhipment container ports, the top decision maker is concerned about volume of import/export transhipment containers and costs, followed by port efficiency, physical port and port location.

Hui and Notteboom, (2004) explained that Shanghai Port represents a favorable transhipment hub port to serve Northeast China was mainly due to its geographical location close to main trade routes as compared to Pusan and Gwangyang. It would explain the increasing market share of Shanghai from 20.7% in 1995 to 28.1% in 2001. In addition, shipping lines are also calling Shanghai Port directly to capatalise large volume of cargo generated from this region. Shanghai Port has better prospect to serve a larger hinterland than Dalian, Qingdao and Tianjin, even though only one percent of the containers handled in Shanghai is sea-sea transhipment.

2.3.2 Shipper's point of view

Ugboma et al., (2006) carried out an Analytic Hierarchy Process (AHP) to understand the criteria used by shippers in Nigeria for port selection decisions. Based on a literature survey, there are seven factors that could explain port choice among shippers located in industrial centre of Lagos and Port Harcourt as follows.
(i). frequency of ship visits, (ii). efficiency, (iii). adequacy of port infrastructure, (iv). location, (v). competitive port charges, (vi). quick response to port users' needs and (vii). port's reputation for cargo damage.

A three-level hierarchy using the Analytic Hierarchy Process was used and leads to the conclusion that efficiency, frequency of ship visits and adequate infrastructure are the major determinants of port choice. They are followed by location, port charges, port's reputation for cargo damage and quick response to port users' needs.

In order to evaluate the third objective of determining the shippers' overall preferences of the ports, priorities were synthesised. The study revealed that for the efficiency, port charges, quick response to port users' needs and reputation for cargo damage criteria, Port Harcourt Port Complex PHPC is preferred while for Ro-Ro cargo, Port RRP is the least preferred. Location and frequency of ship visits criteria is mostly preferred in Lagos Port Complex LPC while adequate infrastructure criterion is mostly preferred by

Tincan Island Port Complex TCIPC. In conclusion, it appears from their study that port efficiency is the most important factor in port selection from the shipper's perspective.

Lirn et al., (2004) also used AHP to study and evaluate the criteria shippers use for transhipment port selection from a global perspective. Methodologically, this is new development in research on liner shipping. Based on a literature survey identifying 47 factors having a significant impact on the choice of transhipment ports selection, the authors catergorized them into 4 main criteria – (i). physical and technical infrastructure, (ii). geographical location, (iii). management and administration and (iv). terminal costs. The result reveals that 20 carriers and 20 terminal operators that were targeted have similar opinion about the determinants for port selection. However, the weight among sub-criteria shows some differences between the two groups. The study also identifies five factors (handling cost, proximity to main navigation route, proximity to import/export areas, basic infrastructure condition and feeder network) are the most important elements in transhipment port selection criteria. The researchers evaluate their findings to be in line with previously identified criteria on shippers' expectations (Slack, 1985); Brooks, 1995).

Tiwari et al., (2004) used a discrete choice model to examine the shipper's determinants of port choice and carriers selection in China. A shipper would have a choice of 14 alternatives based on port and shipping lines characteristic and would choose one alternative. The results stress that the distance of the shipper to port, distance to destination (in case of exports), distance from origin (in case of imports), port congestion, and shipping line's fleet are important factors of the shipper's port and carrier's selection decision. The shippers are fleet size elastic, which means that an increase in the number of vessels by Chinese shipping lines by 1% increases the market shares of those alternatives by around 5.4%–6.1% depending on the port used.

2.3.3 Literature's point of view

Guy and Urli, (2006) apply a discrete multicriteria analysis in their study to understand carriers' behaviour of port selection in the Northeast of North America based on specific set of criteria presented in Lirn *et al,* (2004) and Song and Yeo, (2004). The study used a reverse approach of multicriteria where weight factor is set to common selection rationale. Based on this criteria, they explained why shipping lines call New York. In order for Montreal to be selected by shipping lines, a hinterland coverage must be important criterion for carriers.

Aversa et al., (2005) applied an integer programming model in hub port selection for the East Coast of South America, in the same vein as numerous studies on port selection (O'Kelly, 1986, (1987; Klincewicz, 1991 and Aykin, 1990)). Estimates on the total optimum cost and demand of containers are derived from this programming model for eleven ports candidate for hub status. The study emphasized that centrality, high volumes of domestic (i.e captive) traffic, good hinterland connections, adequate feedering networks, good infrastructure and competitive port pricing have often been considered as the most important factors to become a hub port.

Chou et al., (2004) used mathematical programming techniques to analyse operational costs incurred in two routing systems with direct and transhipment services. Optimal routing strategies have been identified for both services in order to find the economics of the cargo being shipped in the two models. The transhipment option is worth considering if transit costs are lower than inventory cost. This is true for low and medium discharging/loading costs. In case of more vessels being deployed on each route, transit inventory costs become dominant.

2.3.4 Terminal operator's point of view

Ng, (2006) assessed the transhipment attractiveness of the North European container market by applying the Likert-style questionnaire to major shipping lines representing about 66% of the global market. Determinant factors were selected from results from a questionnaire set to CEOs, General Managers, Operation Managers, District Managers, Purchase Managers and Port/Terminal Contract Managers and from a literature review on the attractiveness of the port. In the port users' perspective monetary cost and time efficiency are considered as priority. It was suggested that factors such as geographical location and service quality need also to be considered. His findings suggested that that monetary costs are not the only component in determining the port attractiveness, service quality, time efficiency and geographical location are as important.

2.3.5 Combination

Song and Yeo (2004) addressed port competitiveness and selection by shipping lines in main Chinese ports using AHP to determine priorities. The focus is on factors such as geographical location, logistics and port operation services. They identified 73 factors for port competitiveness based on a survey to 180 ship owners, shipping company executives, shippers, terminal operators, academics and researchers. The five most important criteria for port competitiveness were collected based on expert opinions from 70 specialists. They are cargo volume, port facility, port location, service level and port expenses. The study revealed that location are the most important factors for port competitiveness.

Magala and Adrian, (2008) proposed a model for port choice based on the supply chain perspective. Shippers deal with port and carriers selection on shipping and port factors based on their final decision and from a choice on the overall assessment of the supply chain. They identified the port as a part of a total logistic solution in order to achieve competitiveness. The study stressed that port selection criteria and choice models are directly connected with the supply chain event. Two theories were developed for modeling port choice from a port perspective as an element of a chain system, but they are rather outdated and need new analytical framework. Third party logistic providers who control the freight from the origin to the final destination and aim at minimizing the total logistic cost should be considered.

Lee et al. (2007) conducted a study to investigate factors determining for transhipment port selection among shippers and shipping lines. 38 attributes were used to survey the liners, shippers and container terminal operators adopted from previous studies. The study adopted the one way ANOVA technique to assess if the means of the 38 factors were significantly different across the three market players. The result indicates statistical differences of port selection among the players. An exploratory factor analysis was conducted to assess the dimensionality of 38 factors. The factor resulted into 7 key factors customer service capability', 'advanced port management', 'hinterland and terminal basic condition', 'shipping line operation', 'terminal operation', 'transportation distance', and 'intermodal system'. The ANOVA again was conducted to compare the means scores between the 7 factors to determine the differences. The study revealed significant differences: (i). hinterland characteristics (between liners and shippers, between shippers and terminal operators); (ii). shipping line operation (between liners and terminal operators), and (iii). terminal operation (between liners and shippers).

2.4. Conclusions

This first chapter aims at offering a literature review on the main factors explaining the choice of a transhipment ports as well as studies investigating the hierarchy amongst these various factors (see Table 2). The main factors are classified into three groups namely: (i). Carrier point of view, (ii) Shipper point of view, (iii). Terminal operator point of view, (iv). Technology- bigger ship, (v). Literature and (vi). Combination of the above.

Table: 2 – Factors explaining the choice of a transhipment ports and hierarchy amongst these various factors

Carrier's point of view	Shipper's point of view	Literature's point of view	Combination (port operator, shipper and carrier)
1.Port efficiency (the most preferred) 2.Inland distance 3.Port characteristic/physical 4.Vessel schedule 5.Larger hinterland 6.Volume of import/export transhipment containers 7.Port efficiency	1.Port efficiency (the most preferred) 2. Port chargers 3.Quick response to port users' need 4.Reputation for cargo damage criteria 5.Location 6.Frequency of ship visit 7.Adequate infrastructure 8.Distance of the shipper to port 9.Distance to destination (for export) 10.Distance from origin (for import) 11.Port congestion 12.Shipping line's fleet 13.Handling cost 14.Proximity to main navigation route 15.Proximity to import/export areas 16.Basic infrastructure condition 17.Feeder network	1.Lower transit and inventory cost 2.Larger/good hinterland connection 3.Centrality 4.Volume of domestic traffic 5.Adequate feedering networks 6.Good infrastructure 7.Competitive port pricing	1.Monetary cost (P.O), (S&C) 2.Time efficiency (P.O) 3.Geographical location (P.O) 4.Service quality/level (P.O) (S&C) 5.Cargo volume 6.Port facility 7.Total logistic cost 8.Freight cost 9.Hinterland characteristics

source: Author's compilation from various literatures

Note:

P.O – denote port operators, S&C – denote shipper and carrier

CHAPTER THREE
AN ANALYSIS OF INTRA-ASIAN CONTAINER TRADES

The objective of this chapter is to show the main trends in the Asian container market (section 3.1), to present the major existing transhipment container ports (3.2) and overview of intra-Asian shipping services (3.3).

3.1. Main trends in Asian container markets

This section focuses on the emergence of the Asian container trades as well as the changes in intra-Asian trade. A fundamental shift in world trading patterns and in favor of Asia took place during last 20 years. It is underpinning the buoyant growth in world container demand. Indeed, the strong growth in world container trade has coincided with a rather lackluster performance of most major economies, with the US remaining fragile and Europe failing to meet even modest growth targets.

As a growing proportion of manufacturing is being outsourced to China, Chinese exports increase, while at the same time, more raw materials and semi-finished products are being shipped to China. East Asia accounted for 45% of world throughput and will account for 47% in 2015. The World total estimates 498 million in 2010 and 645 million in 2015. See Table 3.

Table 3 - Container throughput forecast east Asia

Region	2004	2010	2015	%
Northeast Asia	41.7	64	73	75
China	68.3	97	117	71
Southeast Asia	49.1	80	112	128
Total	**159.1**	**241**	**302**	**90**

Source: Ircha and Crook, (2008) Port Management Analysis

It is debatable for how much longer this development can continue, but it is believed that Japanese, US and European manufacturers will continue to transfer production to China for at least another five years, albeit, perhaps, at a slightly lower pace. In the longer term, China is expected to establish itself as the global manufacturing centre due to its abundance of cheap labour, both along its coastline as well as in-land and plentiful supply of land. From 1990 to 2005, the average growth rate of container throughput in China was 24% (currently China has more than 130 ports including coastal and river ports). Its total container throughput in 2006 has reached over 80 million TEU, approaching 20% of the world total. Pertaining to evidence from some liner operators it is now suggested that utilization rates on all trades out of Asia are close to 100%.

According to Meyrick, (1998), the Asian container shipping system has evolved the following four phases of Asian economic development:

(i). The Japan phase, during which Japan completely dominated the Asian industrial scene

(ii). The Tigers phase, during which rapid industrialization in Korea and Taiwan complemented that of Japan, and the city-state hubs of Hong Kong and Singapore began to emerge as major centres of commercial and industrial activity within the region;

(iii). The ASEAN phase, during which Thailand took over as the fastest growing states in Asia; Thailand and Malaysia

(iv). The current phase: the phase of China, during which the massive Chinese economy signaled its arrival as a major international force with several consecutive years of economic growth in excess of 10%.

Table 4 – ASEAN container trade development

ASEAN	2003	2004	2005	2006
Singapore	18,441,000	21,311,000	23,192,200	24,792,400
Malaysia	10,210,145	11,510,931	12,197,750	13,349,428
Thailand	4,232,685	4,855,827	5,115,213	5,574,490
Indonesia	5,176,982	5,369,297	5,503,176	5,668,271
Vietnam	1,904,939	2,273,056	2,537,487	2,999,646
Cambodia	181,286	213,916	211,141	221,490
Brunei	76,515	97,667	101,000	100,719
Total	41,397,552	46,949,694	50,207,213	54,157,810

Source: Containerisation 2006, 2007 & 2008 and Author's own source

ESCAP (2005) estimated the intra-Asian container trade to 22 million TEU in 2002 and will continue to have strong long-term growth prospects due to the following factors:

(i). Sound medium to long term growth prospects for most Asian economies;

(ii). Close proximity of a number of economies at very different levels of economic development;

(iii). The continued importance of more economically advanced Asian economies as sources of FDI for the less developed economies of the region;

(iv). Regional Free Trade Agreements such as ASEAN's Common Effective Preferential Tariff Scheme (CEPT).

The study forecasts that intra-Asian trades will grow at an average rate of 8.3% per annum over the period 2002-2015 as compared with only 3.5%, the average growth rate for other regional trade. (see Table 4)

China, including Hong Kong, China and Taiwan Province of China, will continue to dominate the intra-Asian trade with an expected growth of 9.3% per annum during the period 2002-2015. The study estimates show that South Asian countries trade with other Asian countries will increase at an average rate of 10.4 % over the same period. In particular the trade between these two sub-regions is expected to increase at more than 12% per annum. (see Figure 3)

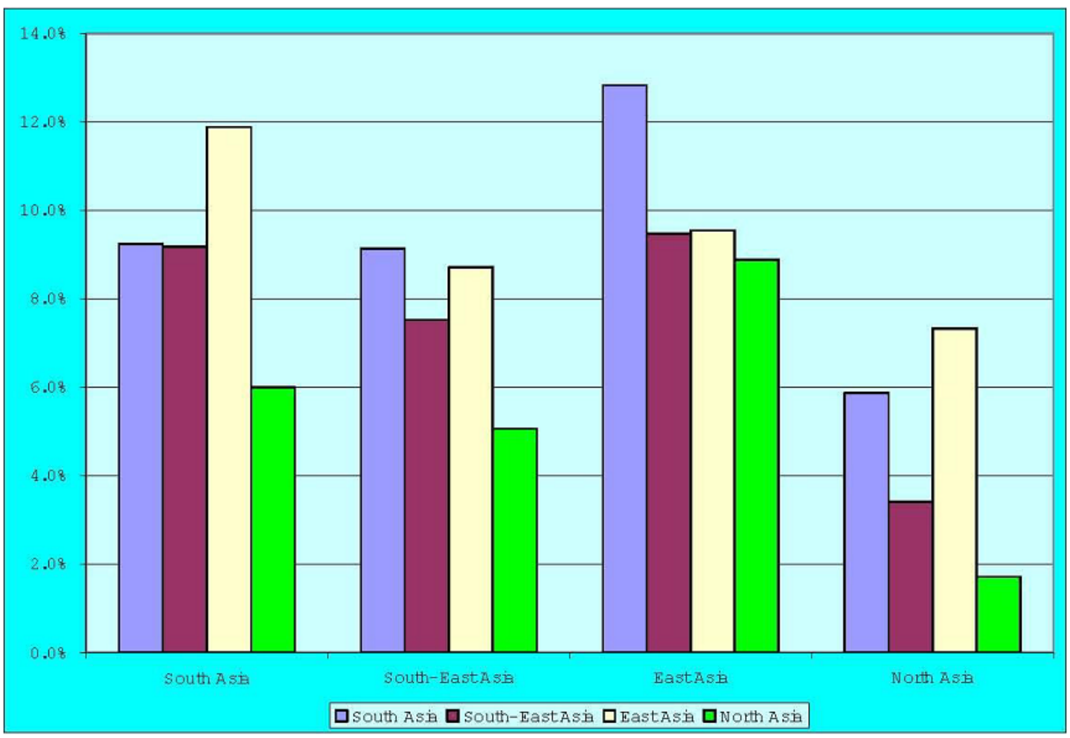


Figure 3 – Asian countries inter-regional trade
Source: ESCAP, (2005)

ASEAN countries' inter-regional trade and containerized trade are expected to grow further under the proposed AFTA initiative with China. A China ASEAN Free Trade

Agreement is expected to be implemented by 2010 (Khalid, 2005). This development will boost regional container trade among East Asian ports, hence required upgrading and development of port facilities. Intra-Asian links have grown over the past decade, which required the needs for development of new ports and facilities to attract global carriers in the regional waters.

3.2. The main Asian transhipment ports

In 1985, the total number of containers handled through the port of East Asia was 12.7 million TEU. In 1996, two individual ports Hong Kong and Singapore reached handled volume in excess of the figures. The total volume of containers in East Asia ports increased by 270 percent from 1985 to 1995. In 1985, East Asian ports handled approximately 40% more cargo than the ports of the United States, the world's largest container market. By 1995, East Asian ports handled over three times the total cargo handled in the USA. (see Table 5)

Table 5 - The growth of container handled in East Asian countries

Economy	1985	1990	1995	2000	2005	2006	2007
Japan	5,517	7,851	10,740	13,500			
Taiwan	3,075	5,430	7,848	12,000	9,467	9,770	10,250
Hong Kong	2,289	5,100	12,549	16,000	22,500	23,500	24,000
Singapore	1,699	5,223	11,800	17,500	23,192	24,792	27,900
South Korea	1,246	2,348	4,502	7,400	11,840*	12,040*	13,270*
Philippines	638	1,383	1,707	2,900	3,710**	3,785**	3,999**
China	446	1,143	4,678	10,900	18,080***	21,700***	26,150***
Thailand	400	1,078	1,962	4,000	5,115	5,574	
Malaysia	389	882	2,086	4,600	12,194	13,349	
Indonesia	229	922	2,197	5,300	5,503	5,668	

Source: Meyrick, (1998), UNCTAD, and Containerisation International

Note:

*Busan port , ** handled by ports under the Philippines Ports Authority only,

***Shanghai port

According to Jung, (2007) market concentration in ports measured by the Herfindhal-Hirschman Index increases until 1995 before decreasing. (See Table 6) Under the hub and spoke system bigger ports grew faster than smaller ports. After mid 1990's the Northeast Asian port market structure has changed drastically due to the move in the shipping network system from hub and spoke to the multiple hub port system.

Table 6 - Trend of HHI for container port market

Year	1985	1990	1995	2000	2005
world	0.021	0.024	0.028	0.023	0.019
Northeast Asia (Korea, China and Japan)	0.151	0.198	0.198	0.141	0.099

Source: Jung, (2007) Trend of container ship growth and port industry market structure change

This trend is explained by the fact that following the introduction of bigger vessels, shipping lines have changed their routing pattern. Bigger vessels only call few ports (hub ports), a strategy particularly true in southern and central China due to the strong growth in container volumes (Tao, 2005).

Two models of hub and spoke networks have however developed in Asia (see Figure 4) known as the Singapore and Hong Kong model. For the former, only one mega-hub acts as the gateway of international transport in the region. For the latter, the Hong Kong model, several ports act as the gateways of cargo flow through the Pearl River Delta (PRD). In northeast Asia, two traditional hubs-Busan, South Korea and Kaohsiung, Taiwan are competing with Shanghai Port which has the tendency to follow either one of the model mentioned above. According to Wang (2000), Singapore and Hong Kong have the advantage over all other ports because they serves as relay ports for intra-Asia transhipments. The growth of 46% to 64% share from 1994 to 1997 confirmed that Hong Kong serves as transhipment gateway for South China, while the share for the rest of the Chinese ports went down from 54% to 36%.

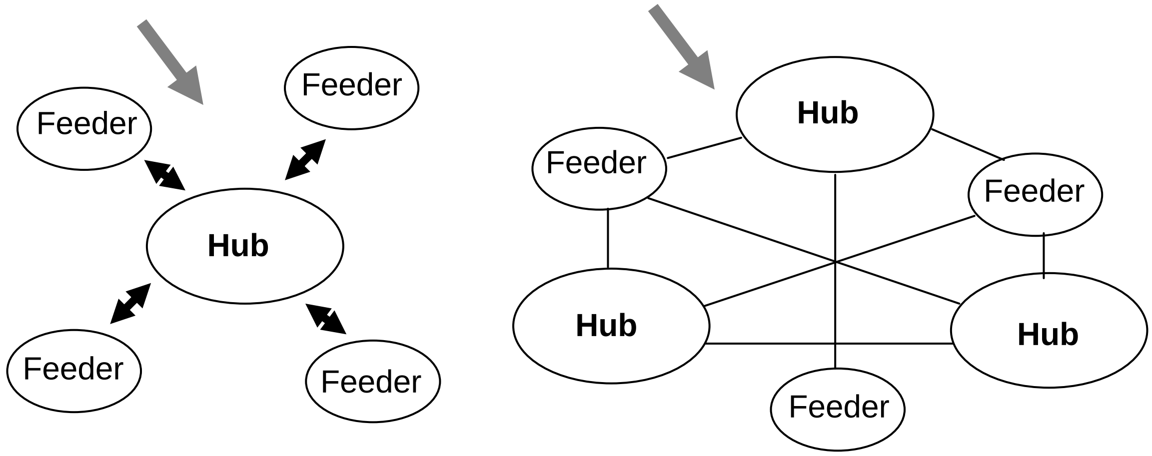


Figure: 4 Two models of hub-spoke networks
Source: Tao, (2005). The emergence of the Yangtze river delta and the responses of Busan and Kaohsiung.

According to Lam and Yap (2007), the emergence of the South East Asian transhipment market, namely Port Klang and Tanjung Pelapas, Malaysia as credible transhipment operations attracted shipping lines to relocate their transhipment hub to these ports from Singapore. Maersk and Evergreen consolidated their transhipment containers in Tanjung Pelepas while CMA-CGM and China Shipping calling at Port Klang. The move enabled Tanjung Pelepas and Port Klang to secure significant gains in market shares in intra-Asian trades as well as an effort to attract other major operators. In addition, the Malaysian ports identified the importance of sufficient local cargo base so as to secure transhipment cargo and to attract more shipping lines to call at the port.

In Eastern Asia, Hong Kong as a global port ranking a higher position in global ports is very important position for the world's leading carrier. For instance, Maersk is using Hong Kong as their hub to integrate its direct shipping services and to ensure global connectivity to other hub ports and feeder ports within Asian shipping. The emergence of pure transhipment hub such as Tanjung Pelapas although ranking a lower position in terms of world port hierarchy, also plays a dominant role in Maersk's maritime network (Maersk left Singapore in December 2000 for Tanjung Pelepas that has increased by factor of 5 between 2000 and 2001, from 418,000 to 2 million TEUs). At the same time Kaohsiung, Singapore and Busan are placed as secondary ports. The reasons for this is they are unable to get major shares and involved in totality in these ports which they regarded fundamental to have in order to limit the total cost of the transport chain.

According to Park *et.al.* (2006), the intra Northeast Asia container market has seen an increase in regional trade volumes since China joined WTO in 2001. The market can be divided into three routes to/from Japan, Korea and China. Most import and export containers on the Korea-Japan route are handled at the port of Gwangyang, Ulsan and Masan which comprise of direct trade cargoes and transhipments. For the Korea-China route the largest portion of Korea’s export and import container cargo (direct trade cargo and container cargo) for China is handled at Busan, Gwangyang and Incheon. But the cross trade route became an issue, so an agreement of fair sharing cargo was adopted to new entry of the Korea-China trade route which limits competition between shipping lines. (See Figure 5).

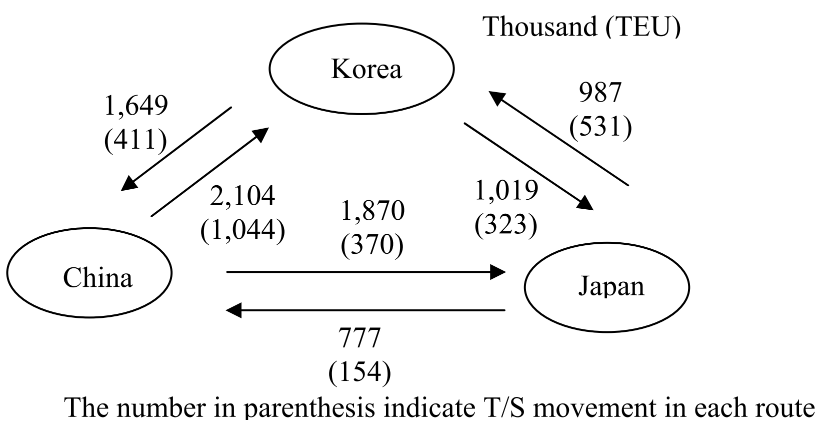


Figure 5: Intra Northeast Asia container volume including T/S volume
Source: Park, (2006). A strategic model for of competition among container ports in Northeast Asia

Loo and Hook (2002) (see Figure 6) stated that the shipping services and port handling are organized according to three sub regions in Asian container ports namely: Northern, Central and Southern Asia. The ports located in Northern Asia are as follows:

Northern Asia	Central Asia	Southern Asia
i. Tokyo	i. Shenzhen	i. Brunei port
ii. Kobe	ii. Hong Kong	ii. Indonesian ports
iii. Busan	iii. Kaohsiung	iii. Malaysian ports
iv. Dalian	iv. Manila	iv. Singapore port
		v. Thailand ports
		vi. Vietnam ports
		vii. Cambodia ports
		viii. Myanmar ports

Therefore, according to that classification MCT is classified in Southern Asia port region.

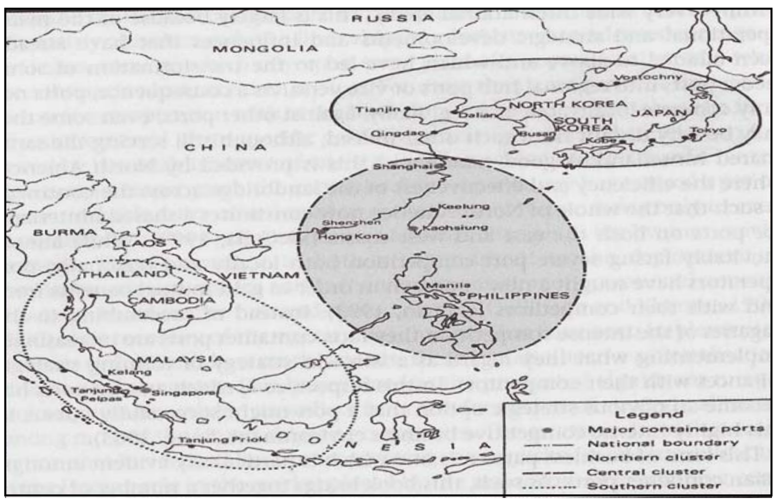


Figure: 6 – Major container ports in Asia
Source: Loo and Hook (2002), Asian container ports

The Port of Singapore is strategically located on the main shipping trade lane, Malacca Straits. Singapore is a hub for transhipment containers in South East Asia. Cullinane *et.al* (2007) stated that Singapore's competitiveness depends on how well it can leverage competitive and comparative advantages of other ASEAN countries. However, Singapore Port is facing intense competition from its neighboring port, Tanjung Pelapas

(PTP). Considering that situation, in order to enhance its relative competitiveness Singapore Port focuses into three main areas:

(i). Further strengthen feeder connection and more importantly to generate intra-regional and external trade volume.

(ii). The government is pursuing a policy to develop the country as International Maritime Centre (IMC) to generate economic spin-off from maritime activities

(iii). To optimize the management of land-based activities such as cargo handling activities and on the seaward side, better management of anchorages and channels.

Further, due to the constraint on the development of available space, Singapore invested in and operates oversea port.

Chen (2007) focused on Kaoshiung, Taiwan the world's top three container transhipment hub ports for Asia in 1980. Due to its strategic location and the introduction of hub and spoke shipping networks, it has attracted transhipment business from Asia and has expanded its hinterland coverage. However, due to political setback between China and the emergence of Chinese container ports, it has not been able to gain competitive advantage during the economic boom in China. The traffic between China and Taiwan instead transshipped to Hong Kong strengthening it further as a hub port. It has not only struggled to keep long term tenancy for its container berth. The authority adopted new strategies to maintain its competitiveness:

(i). Abolished private users to its berth and lease to terminal operators

(ii). Introduced liberalization and privatization of port operations

(iii). Introduced free trade zone (FTZ) in 2004 to better utilize warehouses and container yards

In 2004 the authority decided to build new container berths with deeper drafts and larger yards to increase its competitiveness as well as to attract shipping lines. Back in the 1980s when the Chinese government announced the policy to set up Shenzhen Special

Economic Zone, the business expand and Hong Kong was profiting from the transhipment hub for China's containerized trade as there are no proper container handling facilities at the ports in mainland China and no direct calls by major shipping lines (Wang, 2000). According to Wong (2007) Hong Kong maintains its position as the world's top container ports in the past few decades despite facing fierce competition to its adjacent China mainland port, Schenzhen. The key success factor, such as strategic location, port efficiency, efficient port services, adequate infrastructures and practice good policy mainly benefited from Britain. The competition from Chinese ports may put Hong Kong in a difficult situation to maintain its market share in transhipment containers to China in the future. Hong Kong despite much higher land transport costs and port handling charges compared to its competing ports is due to good governance structure, as highlighted customs procedure in Shenzhen import/export port represent cumbersome border procedures and lack of transparency.

According to Song (2007). Shanghai has a highly developed economy 99% of its foreign trade goods handled by the port. Shanghai and Chinese eastern coastal ports, Ningbo and Qingdao form a network and compliment each other in terms of serving their customers. Shanghai benefit mainly from a high level of Chinese seaborne trade growth that reflects in the volume they handled. Despite being the main hub port for China and significant progress made in its port, it lacks capacity due to slow reaction to the fast growing demand. Not only does the port have an inadequate container-handling facilities but the port is also lacking a large deep-water berth and is weak in modern logistics. Shanghai Port is threatened by competitors these competitors are the emergence ports in mainland Chinese ports. A new deep-water container terminal project on Yangshan island will accommodate 52 berths due for completion in 2020.

According to Ryoo and Hur (2007) Busan is facing intense competition to become hub port for Northeast Asian ports. These competitors are setting up marketing strategies to attract transhipment cargoes by reducing port charges and giving incentives to carriers exceeding fixed volumes. In light of this, the government is preparing to develop the next phase of development and modernization with a logistics port in mind for Northeast Asia. The development is also to accommodate rapidly increasing container traffic. The project called Busan New Port in 1995. A 30 berths container terminal will be developed by 2011 with emphasis on the port as part of the logistic chain with the creation of a free trade zone. The revolution of world trade is that more and more manufacturing industries are outsourced, hence the need for a logistic port. About 80% container volume in Korea is handled in Busan Port. The new project development is divided into different phases as indicated in Table 7. (Moon, 2008).

Table: 7 - Busan port development phase

Phase	Berth	Open	Operator	Remark
1	9	2005-2008	PNC (DPW)	BTO
2-1	4	2008	HJCL	Operation
2-2	4	2008	HMM	Operation
2-3	4	2009	CMA, ZIM	BTO
2-4	3	2011	Under Evaluation	BTO
2-5	5	2015	TBN	TBD

Source: Moon, (2008). Port Management Analysis.

According to Inamura, H. *et.al* (2007) Kobe Port was once the main Asian hub port in the 1970s and 1980s. Since the earth quake in 1995, its performance in the transhipment container traffic fell to less than 10 percent. The port implemented a recovery programme to improve the situation such as reducing cost (recently Kobe reduced port charges by 30 percent to attract more vessels), shortening processing time and improving service level. To maintain its competitiveness Kobe Port embarked on a long term development plan: i. The development of state-of-the-art facilities through the expansion of a wharf, ii. Improvement of the environment to the surrounding areas and iii. Development of the port the environment by providing marine recreation facilities to the public. Moreover, there is cooperation with the Port of Osaka on a super-hub-port project in order to integrate and stream line Port and Customs Law so vessel only pay tonnage at each port irrespective of which port they are calling and to construct Kobe airport for intermodal connectivity.

According to Leong (2007), the building of Port of Tanjung Pelepas (PTP) intensifed new port competition to Singapore as South East Asia's hub port. Critical factors for such undertaking are:

(i). To develop transhipment hub, geography is significant factor
(ii). First class infrastructure
(iii). Competitive pricing
(iv). Creating a business friendly environment
(v). Attracting global players as tenants and partners

PTP identified that there is a global trend in the container shipping and handling industry such as :

(i). Growth in container traffic
(ii). Growth of container shipping fleet and as well as size of vessels increase
(iii). Increase in super post panamax ships which leads to demand for regional hubs, transhipment and feeder services
(iv). Shipping line pursuing profitability through rationalization to achieve economies of scale
(v). Tendency of large carriers owning and managing terminals

Knowing this global tendency and Asian market, PTP developed its strategy and PTP has all the elements in order for shipping to call their port. As a result PTP is able to secure its tenant Maersk Sealand and Evergreen to operate the terminal as their transhipment hub. As a result the throughput is increasing to 4 million TEUs in 2004.

3.3 Overview of intra-Asian shipping services connectivity to terminals in the BIMP-EAGA region

This section provides an overview of interconnectivity between intra-Asian shipping services and the BIMP-EAGA region.

The shipping environment is extremely diverse, comprising:

(i). Local breakbulk operators offering tramping-style services

(ii). Dedicated container liner services, which usually also include ports of call immediately outside the BIMP-EAGA, such as at Manila, Jakarta and Singapore. This also includes a large number of services linking North East and East Asia with Singapore and the Straits region of Malaysia which pass close by Brunei, Sabah and Sarawak, without calling.

(iii). Mainline services transiting Asia with transpacific and/or Europe/Far East/Europe services, which again pass close by Brunei, Sabah and Sarawak without calling

(iv). Feeder operators, both common-user and dedicated runs offered by liner companies. These normally connect with the gateway hubs of port Klang, PTP, Singapore and to a lesser extent Hong Kong, Kaohsiung and Busan.

(v). Cabotage/intra island operators (mainly in Indonesia and Philippines), offering services both within EAGA and to/from regional ports immediately outside, such as Manila, Surabaya and Jakarta. Where most of these cargo a mix of domestic and international cargoes with stripping/stuffing being undertaken at the regional ports (cargo moving from the smaller ports/regions being consolidated into containers in Sabah, Sarawak, Sulawesi, Mandano and parts of Mindanao) before being shipped to ports such as Manila, Jakarta and Surabaya.

(vi). Ferry companies mainly geared to passengers and strongest within Philippines and Indonesia waters.

This paragraph outlines the shipping connectivity between MCT and other ports in the region and extra regional areas.

The current shipping line activities inside and outside the BIMP-EAGA region (see Appendix A) provides an overview of principal liner services to ports to whom MCT is competing for traffic, while (Appendix B) highlights principal liner services to/from ports outside the BIMP-EAGA.

In Appendix A and Appendix B the following can be summarised:

The domestic intra-island carriers of both the Philippines and Indonesia remain a very important part of shipping activity in the BIMP-EAGA region.

(i). The operators engaged in this business carry a relatively high proportion of international traffic that moves to/from the outside regions and secondary hubs, such as Manila, Surabaya and Jakarta. From here the cargo connects with further feeder services into regional gateways such as Singapore, PTP, port Klang and to a lesser extent Hong Kong, although some is moved direct on intra-Asia services to China, Japan and South Korea.

(ii). Additional direct services are also expected to take place between the BIMP-EAGA region and transhipment hubs, such as Singapore, PTP, Hong Kong and/or Kaohsiung, purely for economics reason as this will avoid double transhipment costs. Currently, for instance, most cargo moving out of the BIMP-EAGA region is first shipped to a secondary hub such as Manila, Tanjung Priok and/or Tanjung Perak before being moved onto one of Asia's hub ports and this will double the transhipment cost.

(iii). In this context, MCT's ideal geographical location located at the northern rim of BIMP-EAGA zone as well as closer to the main East/West routes equipped with some of the most modern cargo-handling facilities are appeared to be well suited. However,there is a considerable competition also from other ports in the region the nearest being Kuching, Bintulu and Kota Kinabalu. Each of these ports is keen to exploit a secondary hub role and it is largely for this reason they are investing in new facilities.

3.4 Conclusions

The Asian container markets is continue to increase with average growth of 8.35 percent per annum. Apparently Asian container shipping is following the Asian economic development phase: i. the Japan phase, ii. the Tigers phase, iii. the ASEAN phase and iii. the current phase, the phase of China. It is estimated that intra-Asian container trade will continue to have long term growth prospects. Moreover, following China's intense inter and extra regional trade, ASEAN economies are pursuing AFTA dialogue with China with one thing in mind which is to boost container trade development. Lesson learnt, Malaysian Ports highlighted the importance of sufficient base cargo in order to attract transhipment and shipping lines at their ports.

There are new ports emerging in Asia following intense container trade development. It is clear that competition occur between ports. There are three Asian container port markets for Asian trade. (i). Nothern Asia (ii). Central Asia (iii). Southern Asia. Each market has its main gateway port and act not only to serve the intra Asian market but also the international markets. There is clear competition between these markets as well as ports within its region. Different strategies have been formulated in order to compete and gain competitive advantage over the other ports, such as embarking in a new development phase, reducing port tariff, increasing productivity and efficiency. Intra-Asian shipping is diverse with service extension to the BIMP-EAGA region. It is clear that BIMP-EAGA region has the market potential and many to offer.

CHAPTER FOUR
CURRENT SITUATION AND FUTURE DEVELOPMENT OF MCT

Chapter three stressed the influential factors or a port to become transhipment as well as the main trend for the Asian region. This chapter aims at presenting the situation of Muara Container Terminal (MCT) regarding existing and future facilities as well as the main shipping lines offering services from/to the port (4.2). The last section provides a summary of interviews with shipping agents and forwarders operating in MCT (4.3).

4.1. Current facilities and proposed development

MCT is strategically located at Muara Port in Brunei Bay, to the north of Sarawak and to the South of Sabah. It therefore, appears to be perfectly located to serve the developing economies of Brunei, Indonesia, Malaysia and the East Asean Growth Area, a market of some 50 million inhabitants.

MCT is expected to develop from the current situation (phase 1) through two further phases of expansion until the terminal is almost 21 ha in size and able to offer its customer 580m of quay with five container gantry cranes and container ground storage of almost 3,400 slots (see Table 8).

Table: 8 - Proposed development of MCT (TEU)

Present infrastructure (Phase 1)	Phase 2 development	Phase 3 development
• Total area – 9.98ha • 250m container quay • 2 Panamax cranes • Prime-mover/forktruck handling system • 7 forktrucks, 12 prime-movers, 16 trailers • 1,341 container ground slots • 156 reefer points • 5,00m2 CFS	• Total area – 19.7 ha • 410m container quay • 3 Panamax cranes • 2,622 container ground slots	• Total area 20.08 ha • 580m container quay • 5 Panamax cranes • 3,390 container ground slots • 306 reefer points

Source: Author, data derived from Ports Department

On the basis of the information contained in Table 8, PSA Muara Container Terminal estimates that the terminal's theoretical container handling capacity to be as follows:

- Phase 1 – 250,000 TEU per annum
- Phase 2 – 400,000 TEU per annum
- Phase 3 – 500,000 TEU per annum

Since the formation of the concession for MCT in 1999, and the subsequent operation of the berth from 2000, it is possible to chart the growth of this cargo handling activity. As Table 9 highlights, the number of containers handled at MCT continues to grow, from just over 60,000 TEU in 2000 to more than 100,000 in 2007. On this basis, MCT will then have experienced a healthy average growth of 10% per annum.

Table: 9 - Muara Container Terminal throughput

	2000	2001	2002	2003	2004	2005	2006	2007
Total TEU	60,818	59,712	66,618	73,367	97,667	101,000	100,719	108,000
Utilisation rate %*	24.3%	23.9%	26.6%	29.3%	39.1%	40.4%	40.3%	43.2%

Source: Author, derived from Ports Department and estimate from PSA, MCT*

Note: * the maximum capacity is estimated to 250,000 TEU.

Although the exact timescales for developing Phase II and Phase III of the terminal (which includes both container capacity and facilities) have yet to be determined, it appears from Table 9 that MCT currently has a significant amount of spare capacity available and is in a position to attract more containers shipping customers due to its utilization for 2007 being less than 43%. Next section presents the main shipping lines which were calling at the port in 2000-2003.

4.2. Main customers calling at MCT

Nine different shipping lines were calling at MCT between 2000 and 2003 (see Table 10). Advance Container Line is the first shipping line in volume during this three-year period. However, Hub Line Shipping has increased its volumes with an increase of 41% per annum,

Table: 10 – Main customers at MCT (TEU)

Vessel operator	**2000**	**2001**	**2002**	**2003**	**Cargo growth 00-03**
Advance Container Line	29,504	27,768	27,341	27,435	-2%
Hub Line Shipping	6,912	9,449	14,199	19,221	41%
Malaysian Shipping Corp	2,147	2,019	3,263	5,284	35%
Bintang Mas Shipping	4,329	4,760	5,057	5,285	7%
Tong Joo Shipping	6,951	6,656	7,156	6,544	-2%
Johan Shipping	3,691	4,252	4,629	4,625	8%
Malaysian International Shipping Corp	4,425	3,856	3,988	4,085	-3%
Jesselton Shipping	2,990	1,520	1,471	1,479	-21%
Total	61,021	60,280	67,014	73,959	6.6%

Source: Author, data derived from Ports Department

As next Table 11 stresses, Advance Container Line remains MCT’s major customer, although clearly its share has declined from 2000 (48% of all containers handled at the terminal), to 2003 (37%). This decrease is due to the emergence of Hub Line Shipping, which has seen its 2000 share of only 11.3% rising to 26% in 2003. Other shipping line customers have also been impacted by the additional cargo Hub Line which is carrying Tong Joo Shipping, Johan Shipping, Malaysian International Shipping Corp and Jesselton Shipping, all of whom are seeing a dip of several percentage points.

Table: 11 – Main customer share at MCT

Vessel operator	2000	2001	2002	2003
Advance Container Line	48.4%	46.1%	40.7%	37.1%
Hub Line Shipping	11.3%	15.7%	21.2%	26.0%
Malaysian Shipping Corp	3.5%	3.3%	4.9%	7.1%
Bintang Mas Shipping	7.1%	7.9%	7.5%	7.1%
Tong Joo Shipping	11.4%	11.0%	10.7%	8.8%
Johan Shipping	6.0%	7.1%	6.9%	6.3%
Malaysian International Shipping Corp	7.3%	6.4%	5.9%	5.5%
Jesselton Shipping	4.9%	2.5%	2.2%	2.0%

Source: Author, data derived from Ports Department

The emergence of Hub Line Shipping has decreased its dependency of MCT over Advance Container Line. Furthermore, the type of vessels calling to the terminal were mostly fully cellular container ships and vary from the small Tong Joo Shipping vessels "Carnation" with its 1,595 GT, 5.4m draft and 308 TEU capacity through to the Hub Line Shipping "Saipan" named vessels which generally represent the larger container ships currently calling to the terminal (Table 12):

Table: 12 – Vessel type calling at MCT

Vessel name	Operator	GT	Length (m)	Draft (m)	Vessel TEU Capacity
Kota Buana	Advance Container Lines	4,940	105	6.7	256
Saipan Leader	Hub Line Shipping	9,081	148	8.1	802
Saipan	Hub Line Shipping	7,897	133	7.7	671

Skipper					
Saipan Voyager	Hub Line	10,774	162	7.7	701
Hisbiscus	Tong Joo Shipping	4,126	105	6.6	319
Carnation	Tong Joo Shipping	1,595	110	5.4	308
Johan Amber	Johan Shipping	5,542	120	5.7	352
Salam Makmur	MSC	4,719	120	6.5	278
Mercury Crystal	Bintang Mas Shipping	2,864	91	5.8	240 + general cargo
Ceraka JN III-32	Jesselton Shipping	3,256	98	5.0	168 + general cargo/livestock

Source: Author, data derived from Ports Department

Further assessment of the berthing schedule for MCT reveals that the port enjoys weekly links to a number of other regional and extra-regional ports, as Table 13 identifies. These include notable predominantly transhipment ports, such as Hong Kong, Bangpakong (Thailand), Pasir Gudang (Johor), Port Klang and Singapore, together with other regional BIMP-EAGA facilities, such as Bintulu and Kota Kinabalu.

The shipping routings and ports of call are dictated by shipping operators, such as ACL, HUB Line and Tong Joo Shipping, based on commercial considerations and cargo inducement. It tends to indicate that MCT also acts as a feeder port (transhipment) within the region and the size of the vessels calling (Table 12) also tend to support this view. It is also worth noting that the multi-purpose services highlighted in Table 13, which are indicative of the type of vessel calling to Muara Port, call to the same ports as the purely containerized services; this is further evidence of the frequency of general cargo (non-containerised) that still moves throughout the BIMP-EAGA region.

Table 13 - MCT links to other regional and extra-regional ports

Vessel name	Operator	Local Shipping Agent	Frequency of call to MCT	Berthing window	Port rotation
Kota Buana	Advance Container Lines	Teck Liong	Weekly	Monday	Singapore,MCT, Kota Kinabalu
Selatan Megah	Advance Container Line	Teck Liong	Weekly	Friday	Singapore,MCT,Labuan
Saipan Leader	Hub Line Shipping	Harbour Link	Every 10 days	Monday/Tuesday	Hong Kong,Shanghai,Hong Kong,MCT,Bintulu
Hisbiscus	Hub Line Shipping	Harbour Link	Every 14	Tuesday/Thursday	Bangpakong,Pasir Gudang,MCT,Bintulu
Gileong	Tong Joo Shipping		Weekly	Tuesday	Pasir Gudang,Port Klang,Singapore,Bintulu, MCT
Swee Long Satu	Johan Shipping	Archipelago	Every 14 days	Tuesday/Wednesday /Friday	Port,Pasir Gudang,Kuching,Sibu, Bintulu,MCT,Labuan, Kota Kinabalu, Sandakan,Tawau
Mercury Crystal	Bintang Mas Shipping	Silver Line	Weekly		Singapore,MCT,Labuan, Kota Kinabalu
Ceraka JN III-32	Jesselton Shipping	Bee Seng	Every 14 days		Singapore,MCT,Labuan, Kota Kinabalu

Source: Author, derived from Ports Department

Assessing the number of links currently available to/from MCT to regional/extra regional ports, on the basis of the terminal's berthing schedule in that period, Table 14 provides indication of the ports to which cargo moves from/to MCT. It is clear that connections to/from other regional ports represents the majority of ports of calls (over 53%) with the remainder (46.6%) made to extra-regional facilities.

Table 14 – Links to/from MCT to other regional/extra regional ports

Links to/from MCT to other regional/extra regional ports			
Regional ports	**Number of links**	**Extra-regional ports**	**Number of Links**
Kota Kinabalu	6	Singapore	6
Labuan	4	Hong Kong	2
Bintulu	5	Shanghai	1
Tawau	2	Bangpakong	1
Sibu	2	Johor	5
Sandakan	2	Darwin	1
Pontianak	1	Port Klang	4
Kuching	1		
Total	23		20
% of total	53.5%		46.5%

Source: Author, derived from Ports Department

The following trends in shipping services are likely to be seen in the coming decade:

i.Gradual decline in tramping-style breakbulk services

Tramping style services pick up breakbulk cargo from small ports and consolidate the cargo into containers at regional ports like Manila, Jakarta and Surabaya. These services will remain significant in many areas, i.e ports in Sabah, Sarawak, Sulawesi, Mandano and parts of Mindanao. However, the containerization of the breakbulk cargo at source and the perception that container transport represents a safer and more secure mode of transport will see the decline of tramper style breakbulk services and the rise of dedicated liner services.

ii. Increasing domestic cabotage/intra-island traffic in the Philippines and Indonesia

Domestic cabotage/intra-island traffic within the BIMP-EAGA region for the Philippines and Indonesia in 2007 was 823,000 TEU and 746,000 TEU respectively.

A relatively high proportion of this traffic is international cargo that is imported to or exported from outlying areas of the Philippines and Indonesia via hubs like Manila, Surabaya and Jakarta. This volume is set to grow given China's increasing trade with the region in the next few years.

iii. Additional direct feedering services from the region to gateway hubs for connection to global shipping network.

Additional direct services are also expected to be launched between the BIMP-EAGA region and transhipment hubs, such as Singapore, PTP, Hong Kong and/or Kaoshiung as there will be a need to connect fast growing provinces such as Mindanao, Visayas, Sulawesi and Kalimantan to the shipping line's global network. This is done by linking the ports in these provinces to hub ports, such as PTP and Singapore. Direct feedering is preferred to avoid double transhipment costs.

iv. Increasing number of direct services to BIMP-EAGA region due to intra-Asia trade.

Direct services to/from BIMP-EAGA have grown rapidly in recent years because intra-Asian trade between BIMP-EAGA and countries like China/Hong Kong, Japan, Thailand and Taiwan have increased enough to warrant direct calls to ports, such as Bangkok, Kaohsiung, Hong Kong, Shenzhen, Shanghai and Tokyo/Yokohama. Evergreen has a service linking Bintulu (Sarawak), Manila, Taiwan and Hong Kong. Bintulu is then used as a local transhipment centre, for other ports in Sarawak and Borneo. Hub Line is also offering weekly connections between Shanghai, Hong Kong, Muara and Bintulu. Hub has designated Bintulu as its main relay centre for the region.

4.3. Interview on further needs for MCT

This section aims at providing a summary of interviews with local shipping agent for the above vessel operators namely Teck Liong Trading, Harbour Link Shipping, and Archipelago Development Corporation.

4.3.1 Overview of regional shipping services

The vast majority of North-South intra-Asian services are scheduled solely to main ports, and of those Singapore has by far the heaviest concentration of activity, with nearly half of all services between North East and South East Asia (pure feeders excluded) calling at Singapore.

Those services starting in East Asia (Hong Kong/Taiwan range) rather than North East Asia, are less likely to sail all the way to the Malacca Straits, and instead focus more closely on the Bangkok, Manila and Gulf of Thailand sectors (including Vietnam). These ships would typically be smaller than vessels operating out of North East Asian ports.

There is an almost complete absence of any calls at outports in Sarawak, Sabah or Kalimantan on these services- which are thus reliant, even for intra-Asian traffic, upon transhipment in South East Asia over Singapore, Port Klang, Pasir Gudang or PTP. Evergreen maintains a weekly call at Bintulu on its NSB (North South Bound) service, and Hub Line also calls every ten days on its service from Hong Kong and Sanghai, but for the most part, the links into the outports are almost exclusively with the South rather than the North.

4.3.2 Shipping line services at Muara Container Terminal

Shipping line services at Muara are primarily direct feeder services which link Muara Port with main hub ports like Singapore, PTP and Port Klang. Shipping lines which run these services include Advance Container Line, Hub Line Shipping, Malaysian International Shipping Corporation, Tong Joo Shipping and Johan Shipping.

Muara has also witnessed the trend of direct services to BIMP-EAGA through the introduction, by Hubline, of the Muara-Bintulu-Hong Kong-Shanghai service.

Currently very little transhipment activity takes place at Muara itself for the local region.

Shipping Lines

Whilst there is great number of shipping lines with services into the BIMP-EAGA region, the following trends appear to be common to most lines:

(i). Establishing better connection, both within the region and globally

(ii). Providing faster transit times

(iii). Extending services to more local ports

(iv). Shifting more cargo to unitized transport method

(v). Developing a more integrated logistics network for the region and improving terminal productivity levels

i. Hub Line

According to J. Shim (personal communication, June 5, 2008) of Harbour Link shipping, Hub Line which is part of the diversified Malaysian conglomerate EOX, has established an extensive liner network based on South East Asia. With approximately 20 ships capable of hauling up to 10,000 TEU in service. The carrier has supplemented its services through a series of slot sharing arrangements. In a decade Hub has expanded from single line out of Port Klang to a network spanning from the Mid-East and South Asia in the west to Japan in the east.

Hub's current focus is on China and its homeland in eastern Malaysia, which it wants to develop as a transhipment base for smaller ports located in Sabah, Sarawak and Borneo. Currently, approximately 80% of Hub's liftings come from/are destined for this region.

Direct service from Muara/Bintulu to Hong Kong and Shanghai

Hub runs a direct service between eastern Malaysia and East Asia/China, with direct calls at Hong Kong and Shanghai, a link that the carrier claims is faster and more reliable than competing transhipment options over other South East Asian hubs. Currently, the service is being maintained with three vessels, each loading 700/800 TEU, with Muara and Bintulu served direct in eastern Malaysia.

Direct service from Muara/Bintulu to Thailand and Pasir Gudang

Hub Line’s other mainline service calling direct in eastern Malaysia (also at MCT and Bintulu) links Thailand and Pasir Gudang (Malaysia) on a fortnightly basis and uses a single ship of 420 TEU.

Feedering from Muara to Borneo

At MCT, these services connect with a series of feeder links that Hub operates to/from Sibu, Pontianak, Kota Kinabalu, Sandakan, Tawau and Kuching.

Feedering from Peninsular Malaysia ports to Muara and Kota Kinabalu

Hub also runs two vessels on a weekly shuttle between MCT and Kota Kinabalu and the Peninsula (western) Malaysia ports of Penang, Port Klang and Pasir Gudang.

Box volume on this latter route has grown rapidly in recent years as more operators have switched their relay traffic from Singapore to ports in Malaysia. Hub, for instance, works closely with CMA CGM and its feeder arm Feeder Associate Systems, whose load centre for South East Asia is in the Westport complex in Port Klang.

China Shipping Conatiner Lines and Hanjin also use Hub’s services to eastern Malaysian ports.

ii. Johan Shipping

According to L. T. Chan (personal communication, June 6, 2008) Archipelago Development Corporation, Johan Shipping offers feedering services between East Malaysia and Borneo Island

Based in Kuching (Sarawak) Malaysia, Johan Shipping is involved in the country's domestic and feeder trades. Principally, its services operate between peninsula Malaysia and the gateway/hub ports of Port Klang and Pasir Gudang (important as a handling centre for intra-Asia cargo and as a service centre for the industrial districts of Johor and southern Malaysia), and a full range of eastern Malaysian ports, notably Kuching, Sibu, Bintulu, Miri, Labuan, Limbang, Kota Kinabalu, Sandakan, and Tawau. Johan also calls at MCT.

Uses Bintulu as hub for distribution to Sarawak ports

The East/West Malaysia services are fully supported with local coastal services and Bintulu is used as something of a small distribution centre by Johan for other ports in Sarawak.

iii. Pacific International Lines/Advance Container Line

According to K. T. Hong (personal communication, June 8, 2008) of Teck Liong Trading, PIL/ACL is a family-owned business that is controlled out of Singapore, PIL/ACL is now a top 20 container carrying line, with a total shipboard capacity of more than 100,000 TEU (approximately 100 ships). The carrier's service network spans the whole of the Far East, South Asia, Middle-East, Red Sea, Africa, Australasia and South America.

The ASEAN trading zone is especially significant for PIL/ACL whose services are based on the Singapore hub. It maintains many connections to/from the BIMP-EAGA region, including direct calls at Muara, Kuching, Kota Kinabalu and Sibu. ACL is currently Muara Container Terminal's largest customer volume wise.

In addition to the carrier’s core shipping services, PIL/ACL has launched a range of value-added logistics and supply chain initiatives. These are largely controlled through its subsidiary company Origen Logistics.

4.4 Summary of BIMP-EAGA shipping profile

The above overview of the key shipping lines in the region shows that establishing better connections with and within the BIMP-EAGA region will be an increasing priority for both regional and global shipping lines. This is necessary in the context of increased trade between BIMP-EAGA and other Asian countries.

Increased connectivity to the BIMP-EAGA region can take place in a few ways:

(i). Increasing direct feedering services between BIMP-EAGA ports and key hubs like Port Klang, PTP and Singapore

(ii). Having a regional BIMP-EAGA hub where direct feedering to key hubs can take place

(iii). Direct services from/to BIMP-EAGA ports to/from South/North East Asian ports

(iv). Having a regional BIMP-EAGA hub where direct services are between the regional hub and South/North East Asian ports. A feeder will use the regional hubs as distribution centres for the region.

CHAPTER FIVE

KEY PORT PERFORMANCE INDICATORS (KPI)

The aim of this chapter is to look at the potential for MCT to compete with other ports in the region. This chapter also assess how MCT perform in terms of port indicators. Moreover, port indicators will give ideas about situation of MCT compared to other ports. Port indicators will help the management to identify the port performance and productivity in both the past and present situation. Both performance indicators and productivity are common indicators of port efficiency.

5.1 Port performance indicators based on 2004, 2005, 2006 and 2007 data

The objective is to have an idea about the situation on performance of MCT port compared to other ports and it is also going to help the management to do future planning. The indicators of performance discussed herewith are important tools in assessing the extent level of quality of port services and to have an idea if utilization rate of berth and port quayside equipment is highly utilized. The KPI is divided into three sections (i). introduction and methodology (ii). analysis (iii). conclusions.

5.1.1 Collection and organization of related data and methodology

Imai *et al*, (2007) states that:

"Efficiency and productivity improvement of the terminal are crucial in reducing overall trip duration and costs of shipping lines". Therefore, this element will be addressed in this section.

Performance indicators are calculated using four years of data from 2004 to 2007. The data was collected from Ports Department. The four year period is required so that the trend of total time of ships in port can be measured and assessed. The total number of vessels that called MCT between 2004 and 2007 was 1702. Due to limitation of available data the computation was only carried out on ship's time in port and berth indicators. In order to compare, the data was calculated on a quarterly and yearly basis for the four year period. Raw data 2004 and 2007 was analysed and the final outcome is in Appendix C which comprise of berth occupancy, average vessel arrival, average time in port, average waiting time, average service time and berth side throughput.

5.1.2 Assumption

The following assumption was made for carrying out the calculation.

(i). All information or raw data collected from MCT operational department are reliable and accurate.

(ii). There is no idle time because mooring, engagement of gang, quayside equipment are performed by advanced planning, such as move quayside cranes in advance or during normal breaks, open hatches in advance.

(iii). Port resources are properly utilized therefore financial indicators were not calculated and the operational trend in performance level was observed.

5.1.3 Analysis of performance indicators

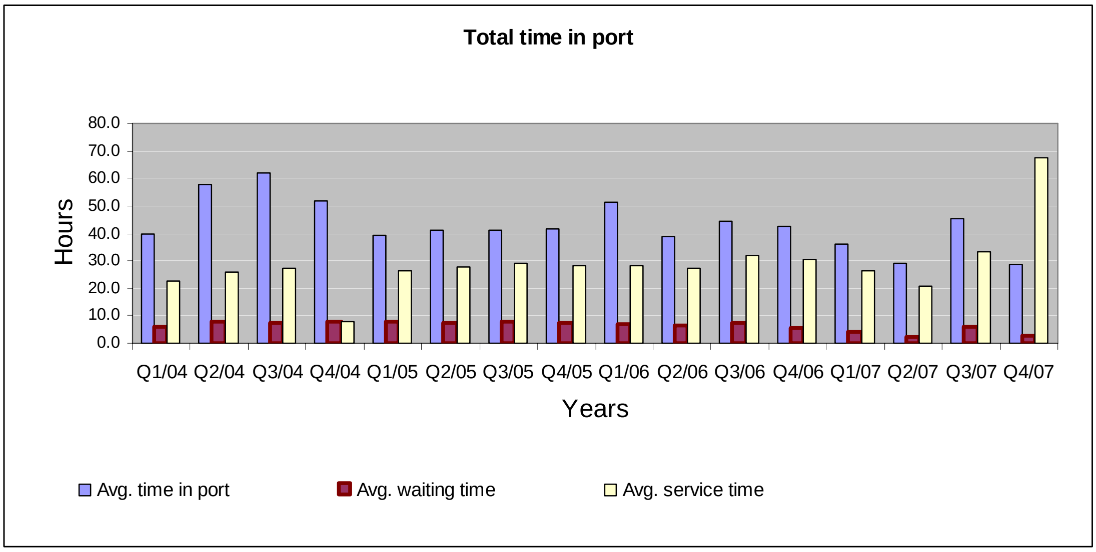


Figure: 7 - waiting time, service time, productive time and turnaround time

Source: Author's own calculation derived from MCT port raw data

The tendency of total time in port varies considerably over the period of four years. The waiting time does not cause fluctuation of total time in port as depicted in Figure 7 is fairly consistent over the period of four years. The fourth quarter of 2006 shows a decrease in average waiting time and with further decrease for the next quarter although there is an increase in quarter three 2007. This could be due to the increase in turn around time in that period. This explains that the terminal operator has efficiently utilized the quayside facilities. The trend for turnaround time appears to influence on the total time in port as it fluctuates over the four year period. The explanation to this is that it can be related to formalities of government agencies, which require a lengthy documentation process such as import and export cargo (customs), delay in pilotage service (marine), Ships and Port Facility Security (ISPS) clearance (port) and limitation of berth quay length which hamper the movement of second a crane to service ships. The average service time more or less followed the same pattern but towards the last quarter of 2007 it increased drastically. This is due to the berth receiving larger ships (bigger than average size ship). There was an interesting development namely that there was an increase of length of overall of ships during the last two year period in 2006 and 2007. The tendency of total time in port is summarized in Table 15.

Table: 15 - Tendency of total time in port from 2004 -2007

Waiting Time (hrs) (WT)	Service Time (hrs) (ST)	Productive Time = Service Time due to zero idle time	Turn Around Time (hrs)
• Range Between 1.06-3.84 hrs per vessel	• Service Time varied from 7.48 to 13.67 hrs per ship	-	• Time varied from 11.27 hours to 23.09 hours per ship call
• The longest on Sep- Oct 2004, the shortest on Dec 2006	• Highest point reached on Oct 2004 while lowest point on Jan 2004	-	• Maximum time on January & July
• Peak time normally on July-Aug	• Peak situation is Oct & Nov	-	• Trend is reducing from 2004 to 2007
• Trend is reducing from 2004 to 2007	• Trend is increasing from 2004 to 2007	-	

Source: Author's calculation data derived from Ports Department

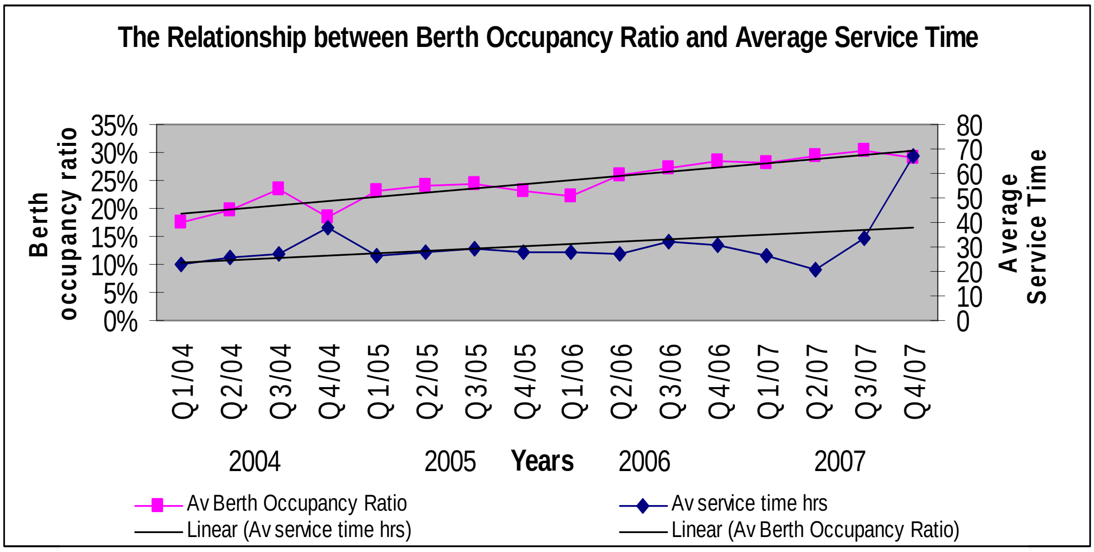


Figure: 8 - The relationship between berth occupancy ratios and average service times

Source: Author's calculation data derived from Ports Department

Figure 8 shows the relationship between berth BOR (berth occupancy ratios) between average ST (service times). They are positively correlated which explains the increase in service time leading an increase of BOR. The higher service time could lead to port congestion therefore, the solution is for the terminal operator to increase its allocation in resources in the quayside area. As pointed out in the previous section, there are several impediments which cause these; among them is limitation in number of berth/quay length.

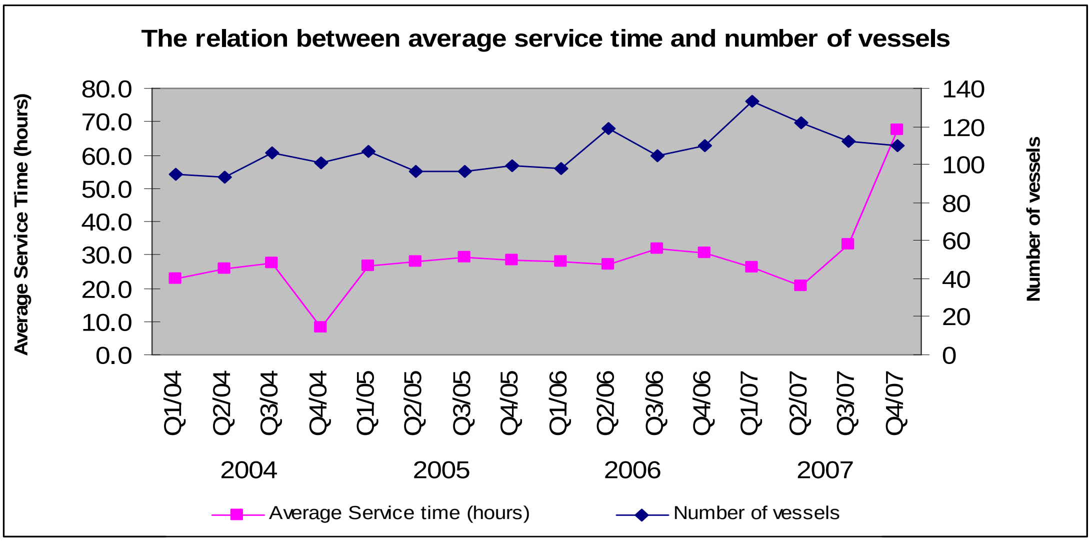


Figure: 9 - The relationship between number of vessels and average service times

Source: Author's calculation data derived from Ports Department

Figure 9 explains that the increase in number of vessel cause the increase in berth occupancy ratio. The number of vessel is proportional to the occupancy ratio. This means that the berth can only serve a limited number of vessels at any one time; when it comes to at certain threshold level in this case at quarter four 2007, it reaches its congested level. Therefore, a new berth needs to be built. This will be estimated in the berth planning calculation in Chapter six.

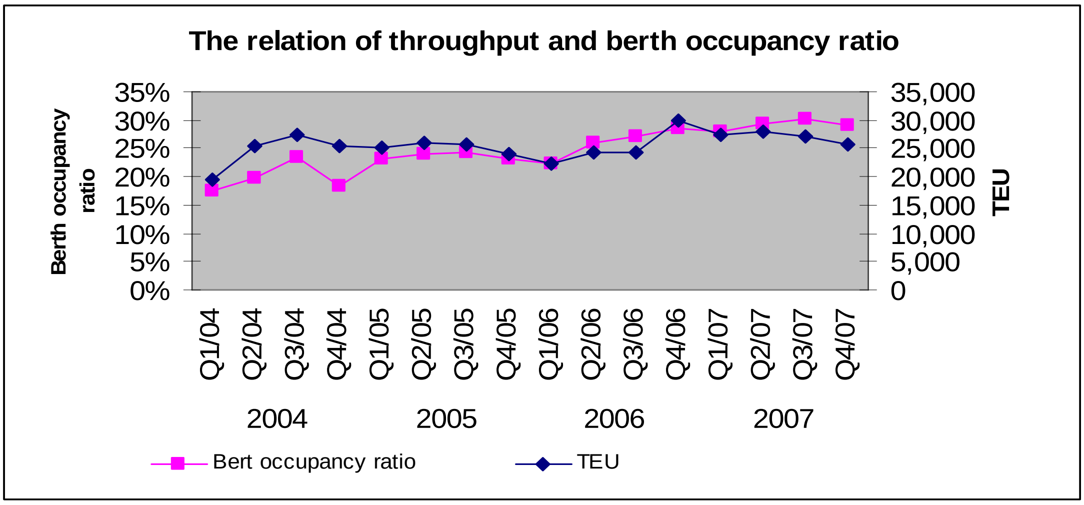


Figure: 10 - The relationship between throughput and berth occupancy ratio

Source: Author's calculation data derived from Ports Department

Figure 10 shows that the throughput and berth occupancy ratio is negatively correlated. In other words, the throughput is inversely proportional to the berth occupancy ratio. Although the number of vessels calling at MCT increases, it does not mean the throughput increases proportionally. This shows that the increase in number of containers alone does not explain that there is an increase in BOR. Therefore, vessel input is a more relevant factor in this case.

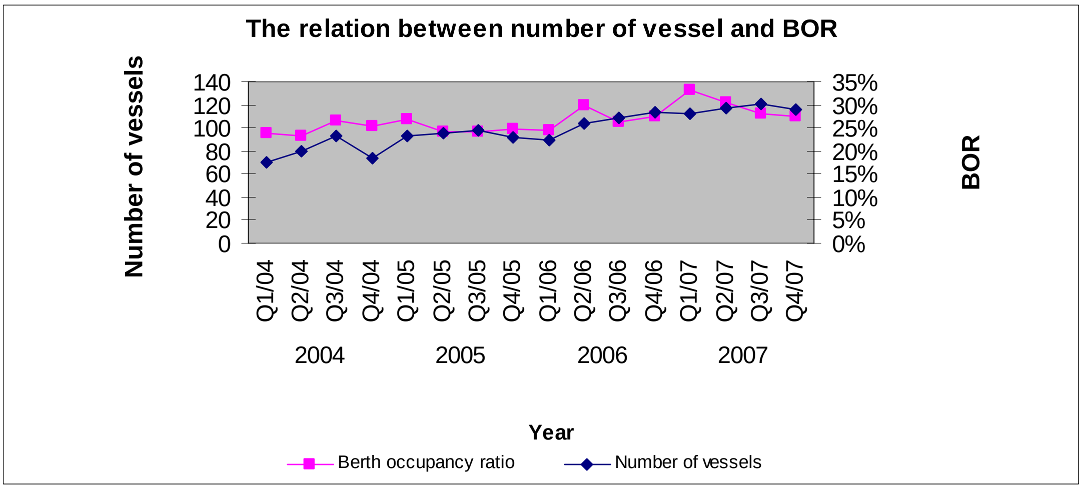


Figure :11 - The relationship between number of vessels and berth occupancy ratio
Source: Author's calculation data derived from Ports Department

Figure 11 shows the relation between the number of vessels and berth occupancy ratio. As the number of ships increased, the BOR increased considerably because berth capacity is increased (higher utilization of berth) due to an increase in the number of ships calling.

5.2 Conclusions

Chapter four aimed to assess the performance and efficiency of MCT operations at quayside area and berth indicators. The assessment focused on the following aspects:

i. Determination of total ship time in port and berth indicators.

In order to determine the port related ship time, port performance indicators are used. Total vessel port time varies through out the four periods because vessels calling at MCT are dependent on many factors such as trade activities in the country. By examining the port indicators for the last four years the tendency of the vessel calling at MCT could be assessed in terms of average number of vessels, size, number of TEUs moves and BOR. All these parameters are important for the assessment. In order to give better understanding of the trend for the four year period, it is necessary to establish a relationship between all these parameters. Amongst them is the relationship between the number of vessel calling at MCT and berth occupancy ratio; as the number of vessels increased the BOR increased considerably because berth capacity is increased (higher utilization of berth) due to ship calls. The total time of vessels in port has increased significantly in the last quarter of 2007. This is due to the increase in service time caused by regular calls of larger vessels at MCT during the period. The trend is bigger vessel call at MCT as explained in the relation between service time and number of vessel. In conclusion there is a need to build additional berth in order to reduce the total time of vessels in port and to reduce port congestion due to an increase in BOR.

CHAPTER SIX

MCT POTENTIAL AS A FUTURE TRANSHIPMENT PORT

6.1 Forecasting future transhipment demand for MCT

This chapter investigates the potential for MCT to become a future transhipment hub in the region. In order to identify various conditions for this to happen, it estimates first the potential future demand (6.1) and then their implications in terms of port investments (6.9) This chapter consists of methodology; traffic forecasting which consider the three elements most likely, pessimistic and optimistic; economic relationship; factors that influence forecasting, analysis and conclusions.

6.2. Methodology

The aim of this study is to assess the current and future performance of MCT berth infrastructure to meet the requirements of the growing market as highlighted in detail in case study one on determination of an optimal number of berths. Olaru and Haji Hallid, (2004) states that most ports will have to increase or modify certain facilities such as the number of cranes, berth structures, changes in container handling facilities such as the number of cranes, berth structures, changes in container handling method and terminal planning to meet the demand.

A planning period of 12 years is assumed. T in line with the general practice for port first phase master plans, with a horizon of 10 years (medium term) in Figure 12.

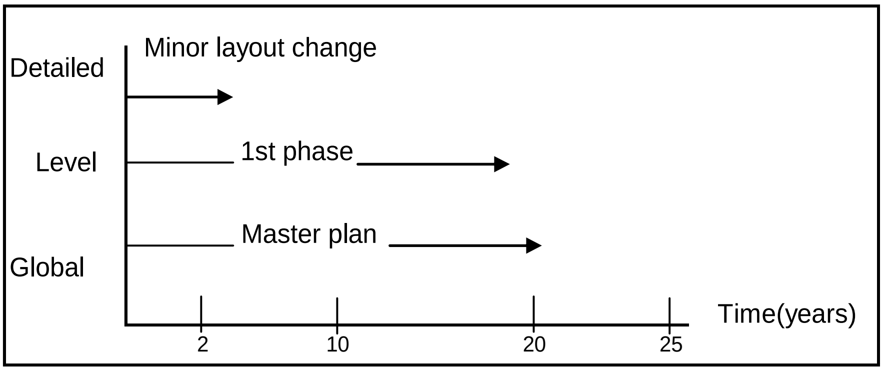


Figure: 12 - Short, Medium & Long term plan
Source: Author's own compilation

The three following steps (Makridakis and Wheelwright, 1987) are:

(i). Identification of key environmental sectors- correlation analysis;

(ii). Forecasting of key environmental sectors- by looking at a reliable sources;

(iii). Conditional forecasting for alternative strategic option- by scenarios

Several influential factors and casual relationship affect the demand for container traffic: economy, population, purchasing power, GDP. A relationship between container traffic and these influential factors are established by determining variables in order to quantify the influential factors. Five variables that give strong relationship to the container traffic are considered as it will have significant affect on the volume of container traffic. The framework for container traffic forecasting is explained in Figure 13.

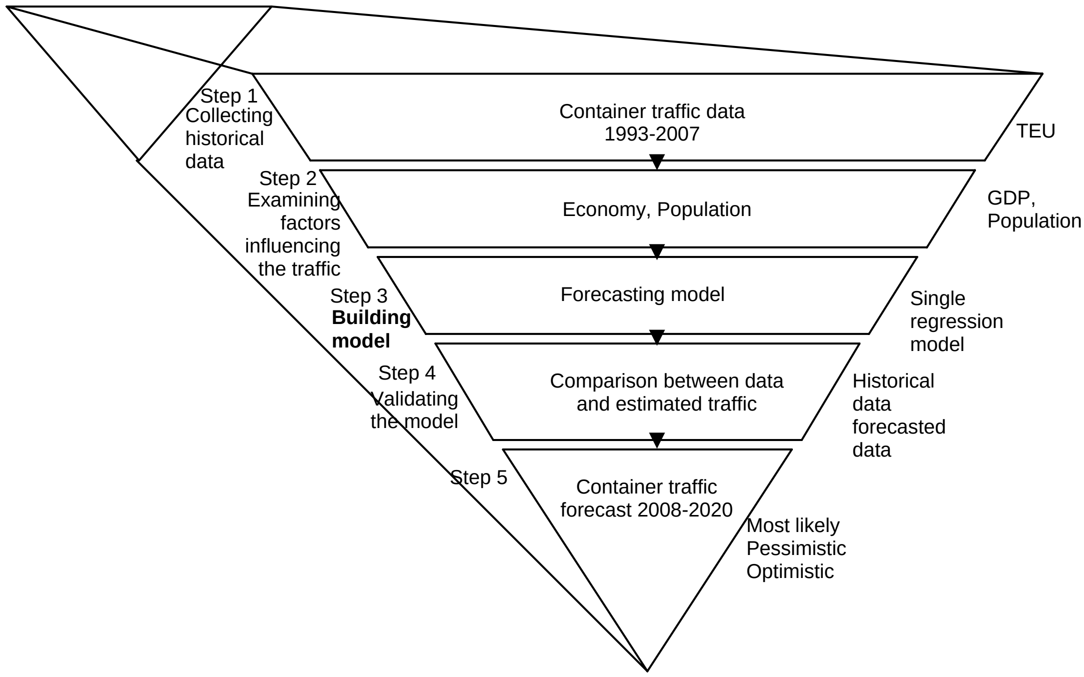


Figure: 13 - Container traffic forecasting framework
Source: Author's own compilation

Historical data for independent and dependent variables were collected from official source such as Economic Development Department of Brunei (JPKE) (2008), IMF (2008), World development indicators database (2008), Ports Department (2008), and ASEAN Secretariat (2008). It appears that the real GDP of Brunei is highly dependent on the contribution of the oil and natural gas (almost 50% of GDP) to finance its policy of economic diversification and the country is the third largest oil producer in South East Asia, producing around 219.300 barrels per day in 2001 CIA World Factbook (2008) (of which around 94% exported), and is one of the largest producer of liquefied natural gas (LNG) in the world. The production of oil and gas has remained fairly constant over the years. Fluctuation of world market prices for these products therefore affects the economy directly.

The correlation between economic growth of Brunei and local throughput was strong over the last 14 years (see Table 17). This is mainly due to the fact that the majority of cargo are local. Although world and ASEAN economy appeared to be strongly correlated to MCT container throughput, it may not be sustainable in the near future

and less accurate for the long-term projection. Therefore, GDP of Brunei for long term forecasting was used.
MCT is the sole gateway for Brunei import/export containerized cargo. With cross-border movement of to/from Malaysia being, for practical purposes, negligible due to the high costs and considerable bureaucratic constraints, the MCT local market is essentially defined as the Brunei national cargo.

For the future, further relaxation of the regulations affecting the use of third country ports as import/export gateways is expected as the ASEAN block develops as a single market and removes tariff and non-tariff impediments to trade. If and when this happens, MCT's volumes can either increase or decrease depending on the comparative costs between competing neighbour ports.

As the time and extent of trade liberalization is not predictable, the future development of local traffic at MCT is assumed to continue under the same regulatory and customs environment that has been applied in recent years, which should make for reasonably consistent traffic development.

Total Brunei local container traffic (imports, exports and empties) has grown at an average of 2.5% per annum since 2000 (see Chapter 7). A detailed traffic breakdown is not available, but to obtain a wider perspective, it is appropriate to observe that total port throughput at Muara reportedly peaked at 108,000 TEU in 2007 because the development of some transhipment business has recently boosted the total throughput.

6.3 Quantitative influential factors

One of the influential factors as discussed above is the GDP. JPKE data records GDP growth averaging 1.8% per annum for the period 1993-2007. Based on an official estimate the population of Brunei were 390,000 in 2007 with a 2% average annual growth. The population of Brunei, which constitutes the primary driver of demand for containerized import cargo, is small. Container activity per head of population is also high. 2007 should see a ratio of around (108,000 TEU/390,000) 277 loaded TEU per thousand head of population. This indicates a heavily trade dependent economy, but equally one that is already largely containerized. Although there are no reliable figures for the container penetration of the Brunei local general cargo market, this would strongly suggest there is little residual growth to come from any further shift into boxes.

Since 1993, the ratio of GDP growth to estimated local container trade growth (average 6.5% per annum) for Brunei has been 2.0 (6.5%/3.16%), which is right in line with multiples observed by Drewry in other developing economies during the 1990s (Table 16)

Table: 16 - Comparison of GDP: container trade multiples (local cargo only)

Country	Period	Multiple
Panama	1991-1998	1.4
Argentina	1991-2000	1.6
Thailand	1990-1996	1.6
Oman	1992-2002	1.7
Brazil	1989-1998	1.7
Seri Lanka	1990-1997	2.4
Yemen	1991-2001	2.8
India	1990-1997	2.9
Brunei	1993-2007	2.0

Source: Drewry Shipping consultant

Table:17 - Relationship of Brunei container volumes and national economic activity, 1993-2007 (TEU)

Data Series Correlated Against GDP	Period	Correlation Factor
Total local traffic	1993-2007	0.85
Total local traffic	2000-2007	0.88

Source: Author's own calculation derived from JPKE data

The above factors require that a relatively conservative assessment be adopted on future GDP container trade multiples. Regression analysis has been performed on a variety of data sets charting the development of the local Brunei container market and national economy activity (GDP), and the result of this analysis is summarized in Table 17 and 18. The correlation of data set in the table seems to be strong.
Table 18 highlights five influential factors and their correlation to the growth of MCT container volume.

Table 18 Influential factor to the throughput of MCT

		Variables				
Year	Total Local TEU	Brunei GDP per Capita (US$)	Brunei GDP (US$) Billion	Brunei Population	World GDP (US$) Trillion	ASEAN GDP per capita
1993	50000	15804	4.52	286	24.5	
1994	58516	15734	4.61	293	26.36	-
1995	71050	15833	4.75	300	29.16	-
1996	83491	15584	4.8	308	29.77	1,505
1997	78564	15651	4.93	315	29.21	1,429
1998	59238	14644	4.73	323	29.41	947
1999	61543	14653	4.85	331	30.49	1,079
2000	60818	14720	4.99	339	31.37	1,128
2001	59712	14500	5.03	347	31.22	1,058
2002	66618	14592	5.18	355	32.38	1,153
2003	73367	14945	5.44	364	36.44	1,266
2004	97,667	14585	5.44	373	40.93	1,473
2005	101,000	17926	6.74	376	44.03	1,615
2006	100,719	18560	7.09	382	54.75	1,902
2007	108,000	18487	7.21	390	54.35	2,225
r		0.71	0.85	0.73	0.87	0.93
r2		0.51	0.73	0.53	0.76	0.87

Source: Author's own calculation derive from various source

i. Forecasting of the Brunei GDP and local throughput – Figure 14

(i). Forecasted Brunei GDP from 2008 to 2020 was calculated using growth as it looks more realistic when compared to the moving average.

(ii). The forecasted MCT local TEU for 2008 to 2020 was calculated using the regression formula y= 17641x – 19099.

(iii). Forecasted throughput growth to 2020 = (245,466-108,000) / 108,000*100= 127%

(iii). 2008 growth= (115,464-108,000) / 108,000*100=6.9%

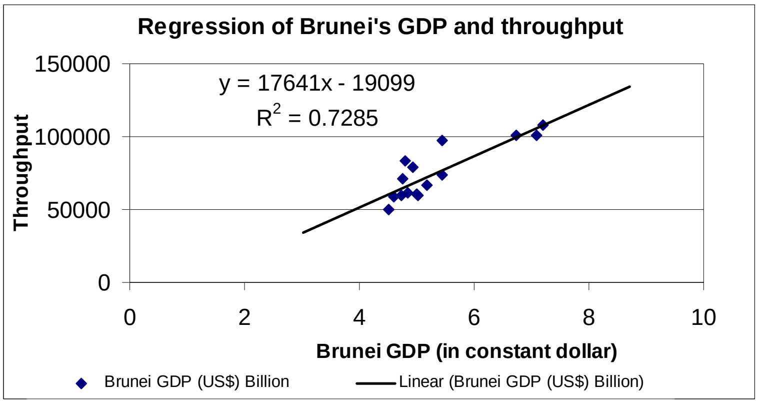


Figure: 14 - Regression of Brunei's GDP and throughput
Source: Author's own calculation derived from various source

ii. Forecasting of the Brunei GDP and population – Figure 15

(i). Forecasted Brunei population from 2008 to 2020 was calculated using growth as it looks more realistic when compared to the moving average.

(ii). The forecasted MCT local TEU for 2008 to 2020 was calculated using the regression formula y= 399.07x – 59850.

(iii). Forecasted throughput growth to 2020 = (149,030-108,000) / 108,000*100= 38%

(iv). 2008 growth= (101,377-108,000) / 108,000*100=6.1%

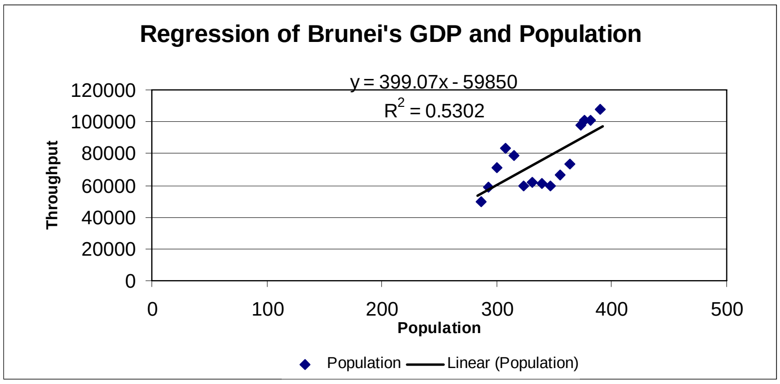


Figure 15 Regression of Brunei's GDP and population
Source: Author's own calculation derived from various source

6.4 Judgemental influential factors

Judgemental influential factors are difficult to quantify as they can influence the degree of trade, especially Brunei trade dependent economy as a majority of cargo are containerised and would affect the container throughput to the country. Forecasting tools such as expert opinions, market surveys and SWOT analyse can be used to highlight any future trend and risk associated with such undertakings Ma, (2008).

i. Government Taxation: The Brunei-Japan partnership agreement enables the automobile customs duty to zero percent (Brudirect, 2008). This liberlisation and fcillitation of trade would promote economic cooperation and reduce the trade barrier between the two countries. As a result of this an increase in import of automobile parts to Brunei will be expected. Further, tax cut is on other items are also being considered. Expert opinions and market surveys may assist the evaluation of such process. Information based on perceptions may give better indications of future patterns of consumption Ma, (2008).

ii. Government Decision: Any decision on diversification of future Brunei economy will certainly have a significant impact on the increase of container throughput in the future. This is reflected in the cargo forecast for 2010 onwards in which Brunei is beginning to industrialise and containerization is taking place on a larger scale as quoted in BEDB, (2008). Such aggressive growth plan has been considered in section (ii). component 2 and (iii). component 3.

6.5 Estimate of MCT potential throughput for three different scenarios

In order to estimate MCT future throughput three components were considered. The three components considered BEDB economic diversification plan among other things include the development of transportation and logistics sector. This promised to deliver exponential growth of Brunei base cargo reflected in component 2 and 3:

(i). Component 1: The Brunei GDP (constant dollars)

(ii). Component 2: As a result of judgemental influential factors as described in section ii. (component 2). The large scale (heavy) industry investment options are considered in the forecasting throughput.

(iii). Component 3: The development of other industrial sites

i.Component 1: After analyzing the relation between throughput and influential factors above, the Brunei GDP (constant dollars) seems to form a strong relationship. This is illustrated in Figure 14. Due to the uncertainty in the key variables it was decided to choose a range of values in order to reflect the situation during an uncertainty event as follows:

(i). Most likely case

(ii). Pessimistic case and ;

(iii). Optimistic case

As concluded by economic analysis, the Brunei real GDP growth, including the revenues from the oil and gas, has been historically lower than the average for the Southeast Asian region, due to the high dependence of the Brunei economy on the oil and gas revenues. The result is a 3 % historical growth of the real GDP for the 1999 to 2004 period (UN statistics). This is comparatively lower than ASEAN's GDP with an average of 6%. It was then, decided to use a data set of 2003 to 2007 to give an average growth of 5.8%, which seems to be realistic. Therefore, a 5.8% GDP growth is the most likely case used for estimation of TEU for 2008 to 2020.

No forecast of Brunei GDP for 2009 and longer term projections are published, and it is deemed reasonable to assume that the long term average growth after 2007 will be the same as in the last five years – 5.8% per annum and stands more reasonably as a most likely case. The fifteen year (1993 to 2007) average growth of 3.16% is thought to be on the lower side. Therefore, the Pessimistic Case assessment 3.16%, was used and the spread between the two (2.64 percentage point) has been used to establish a realistic upper limit for the Optimistic Case forecast – ie GDP growth averaging 8.44% per annum.

ii. Component 2: The preferred large scale (heavy) industry investment option. The government has identified an Alumina Smelter and tyre recycling plant as the first preferred large scale (heavy) industry option. The development of these projects has entered the feasibility stage. Therefore, this study will consider these projects to go ahead and assumes construction will start in 2014. In 2017 the production of both industrial plants will commence and reach full capacity in 2017. A linear production increase is assumed during these 3 years. After 2017 the plants will operate at full capacity. Based on a literature survey, relevant information for an Alumina Smelter of 600,000 tonnes per annum Alumina intake and for a Tyre recycling plant of 800,000 tonnes per annum Shredded tyres intake, is compiled and evaluated.The individual raw materials and products of these plants can be combined into 3 groups consisting of containerised cargo, multi-purpose cargo and dry bulk; the individual materials and products can be found in Figure 16.

-The containerised cargo is the sum of thermoplastic, scrap steel, textile waste, thermo elastomers, aluminium fluoride and other, ingots and waste and others. This totals 483,100 tons containerised in 80,508 TEU's

-The multi-purpose cargo is the sum of scrap steel, textile waste, thermoplastic elastomers, Aluminium fluoride, ingots and waste and others. This totals 861,100 tons.

-The dry bulk is the sum of powder bulk (alumina and petroleum coke) and other dry bulk (pre shredded tyres and thermo plastic rubber). This totals 1,635,000 tons.

Stage 2: Proposed heavy industry				
Tyre recycling plant	Import		Export	
	Tons	TEU	Tons	TEU
Pre shreded tyres	800000			
Thermo plastic rubber	112400	3707		
Scrap steel			93500	3100
Textile waste			67000	2200
Thermo plastic elastomers			488000	30000
Empty containers		31593		
Total cargo throughput	912400	**35300**	648500	**35300**
Total TEU	80508			

Alumina smelter	Import		Export	
	Tons	TEU	Tons	TEU
Alumina	600000			
Petroleum coke	123000			
Aluminium flouride and others		107		
Ingots			200000	4167
Waste and others			12600	787
Empty containers		4847		
Total cargo throughput	723000	**4954**	212600	**4954**

Figure: 16 – Proposed heavy industry
Source: BEDB economic diversification

iii. Component 3: The development of the other industrial sites

The cargo volumes resultant from the development of the other planned industrial areas (total area of 420 ha) are difficult to estimate as no details are available. On the basis of the following assumptions a best estimate has been made

-the total raw materials import and total product export consists of containers only, measured in TEU.

-the manufacturing investment projects produce 500 TEU per built ha per year, including imported and exported containers.
-the total average TEU load is assumed to be 11 ton/TEU
-the planned manufacturing capacity is assumed to come on stream between 2012 and 2020 on a linear basis.
The total built manufacturing area is assumed to cover 50% of the total area (thus 210ha). This results in a total of 105,000 TEU's and total containerised tons of approx. 1,155,000 tons for the year 2020.
The uncertainty in the assumptions made is very high; therefore, the above calculated value will be taken as the average. A high estimate of 1,000 TEU per built ha per year will be assumed and a low estimate of 250 TEU per built ha per year. For each of these values a scenario line will be constructed.

The three local cargo forecasts (Most likely, Pessimistic and Optimistic) are presented in Tables 19, 20 and 21 respectively.

The Most likely Case projects average annual growth in total cargo throughput of 5.8% per annum between 2008 and 2020, resulting in an annual volume of 245, 466 TEU by the end of the period.

Table: 19 - Forecast of MCT throughput, most likely case

Year	GDP Growth (%)	GDP $US billion	Population thousand	GDP per Capita $US	Total Local Teu
1993	0.5	4.52	286	15804	50000
1994	1.8	4.61	293	15734	58516
1995	3.1	4.75	300	15833	71050
1996	1.1	4.8	308	15584	83491
1997	2.6	4.93	315	15651	78564
1998	-4	4.73	323	14644	59238
1999	2.6	4.85	331	14653	61543
2000	2.8	4.99	339	14720	60818
2001	0.8	5.03	347	14500	59712
2002	3	5.18	355	14592	66618
2003	5.1	5.44	364	14945	73367

2004	0.1	5.44	373	14585	97,667
2005	0.4	6.74	376	17926	101,000
2006	5.1	7.09	382	18560	100,719
2007	1.8	7.21	390	18487	108,000
2008	5.8	7.628	404	84713	115,464
2009	5.8	8.070	413	87647	123,263
2010	5.8	8.538	422	91055	131,513
2011	5.8	9.032	431	95259	140,242
2012	5.8	9.556	440	99827	149,477
2013	5.8	10.110	449	105220	159,246
2014	5.8	10.696	459	109495	169,583
2015	5.8	11.315	469	113709	180,518
2016	5.8	11.971	479	117802	192,086
2017	5.8	12.665	489	120987	204,326
2018	5.8	13.399	500	123417	217,274
2019	5.8	14.176	511	125348	230,973
2020	5.8	14.997	523	125141	245,466

Source: Author's own calculation derived from various source

Table: 20 - Forecast of MCT throughput, pessimistic case

Year	GDP Growth (%)	GDP $US billion	Population	GDP per Capita $US	Total Local Teu
1993	0.5	4.52	286	15804.20	50000
1994	1.8	4.61	293	15733.79	58516
1995	3.1	4.75	300	15833.33	71050
1996	1.1	4.8	308	15584.42	83491
1997	2.6	4.93	315	15650.79	78564
1998	-4	4.73	323	14643.96	59238
1999	2.6	4.85	331	14652.57	61543
2000	2.8	4.99	339	14719.76	60818
2001	0.8	5.03	347	14495.68	59712
2002	3	5.18	355	14591.55	66618
2003	5.1	5.44	364	14945.05	73367
2004	0.1	5.44	373	14584.45	97,667
2005	0.4	6.74	376	17925.53	101,000
2006	5.1	7.09	382	18560.21	100,719
2007	1.7	7.21	390	18487.18	108,000
2008	3.16	7.438	404	84,713	112,114
2009	3.16	7.673	413	87,647	116,263
2010	3.16	7.916	422	91,055	120,544
2011	3.16	8.166	431	95,259	124,959

2012	3.16	8.424	440	99,827	129,514
2013	3.16	8.691	449	105,220	134,213
2014	3.16	8.965	459	109,495	139,061
2015	3.16	9.249	469	113,709	144,062
2016	3.16	9.541	479	117,802	149,221
2017	3.16	9.843	489	120,987	154,544
2018	3.16	10.154	500	123,417	160,034
2019	3.16	10.475	511	125,348	165,698
2020	3.16	10.807	523	125,141	171,542

Source: Author's own calculation derived from various source

Table: 21 - Forecast of MCT throughput, optimistic case

Year	GDP Growth (%)	GDP $US billion	Population	GDP per Capita $US	Total Local Teu
1993	0.5	4.52	286	15804.20	50000
1994	1.8	4.61	293	15733.79	58516
1995	3.1	4.75	300	15833.33	71050
1996	1.1	4.8	308	15584.42	83491
1997	2.6	4.93	315	15650.79	78564
1998	-4	4.73	323	14643.96	59238
1999	2.6	4.85	331	14652.57	61543
2000	2.8	4.99	339	14719.76	60818
2001	0.8	5.03	347	14495.68	59712
2002	3	5.18	355	14591.55	66618
2003	5.1	5.44	364	14945.05	73367
2004	0.1	5.44	373	14584.45	97,667
2005	0.4	6.74	376	17925.53	101,000
2006	5.1	7.09	382	18560.21	100,719
2007	1.8	7.21	390	18487.18	108,000
2008	8.4	7.819	404	84,713	118,828
2009	8.4	8.478	413	87,647	130,469
2010	8.4	9.194	422	91,055	143,092
2011	8.4	9.970	431	95,259	156,781
2012	8.4	10.811	440	99,827	171,625
2013	8.4	11.724	449	105,220	187,722
2014	8.4	12.713	459	109,495	205,178
2015	8.4	13.786	469	113,709	224,107
2016	8.4	14.950	479	117,802	244,634
2017	8.4	16.212	489	120,987	266,893
2018	8.4	17.580	500	123,417	291,030
2019	8.4	19.064	511	125,348	317,205

2020	8.4	20.673	523	125,141	345,590

Source: Author's own calculation derived from various source

In the Pessimistic Case, average annual growth in total local cargo throughput is just 3.16% per annum between 2008 and 2020, and the annual volume reaches 171,542 TEU by the end period.

6.6 Model Validation

In order to validate the model used for forecasting container traffic, a model validation is used by comparing base year aggregate containerized traffic and forecasted traffic predicted by the model. Figure 17 represents the actual and model data. In comparison, the data differ slightly due to dependent variable on that particular year in this case year 2003 and 2004 has not seen an increase in GDP (in constant dollars); the same between 1995-1997 a slow increase in GDP due to Asian economic crisis is a major contributor. Generally the validity of the model is acceptable and can be used for forecasting future container traffic demand due to strong correlation of data set. Therefore, the author used this model to forecast the demand for container traffic for the next twelve years, 2008 to 2020.

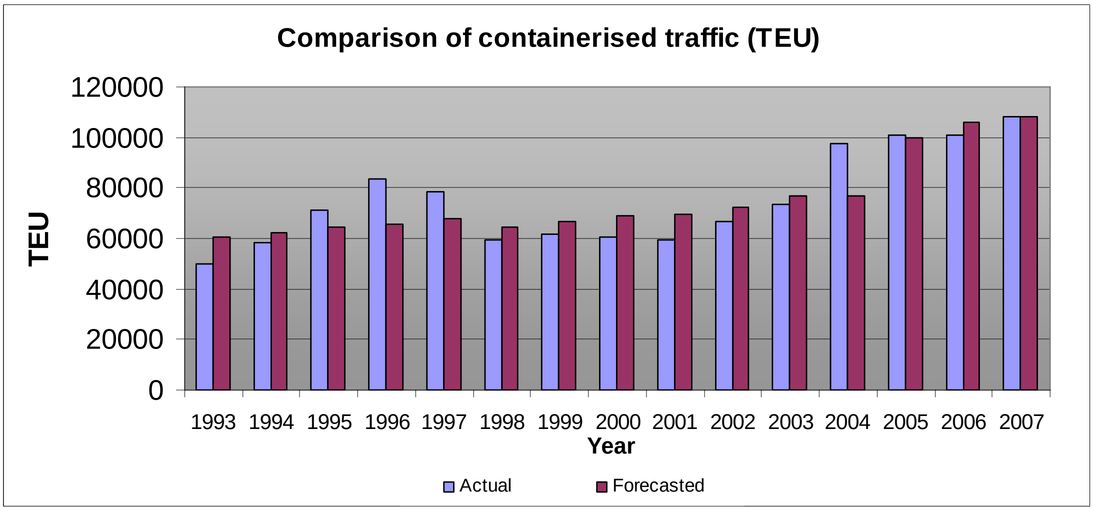


Figure: 17 - Comparison of containerized traffic in TEU actual v.s model

Source: Author's own calculation derived from various source

6.7 Outcome of total cargo volume (TEU)

The outcome of the total cargo volume for any chosen year will be the result of the addition of the three individual scenarios (Most likely case, Pessimistic case and Optimistic case for the components 1 plus component 2 and 3) see Figure 18. The Most Likely case scenario data will be used for berth calculation on section 6.9.

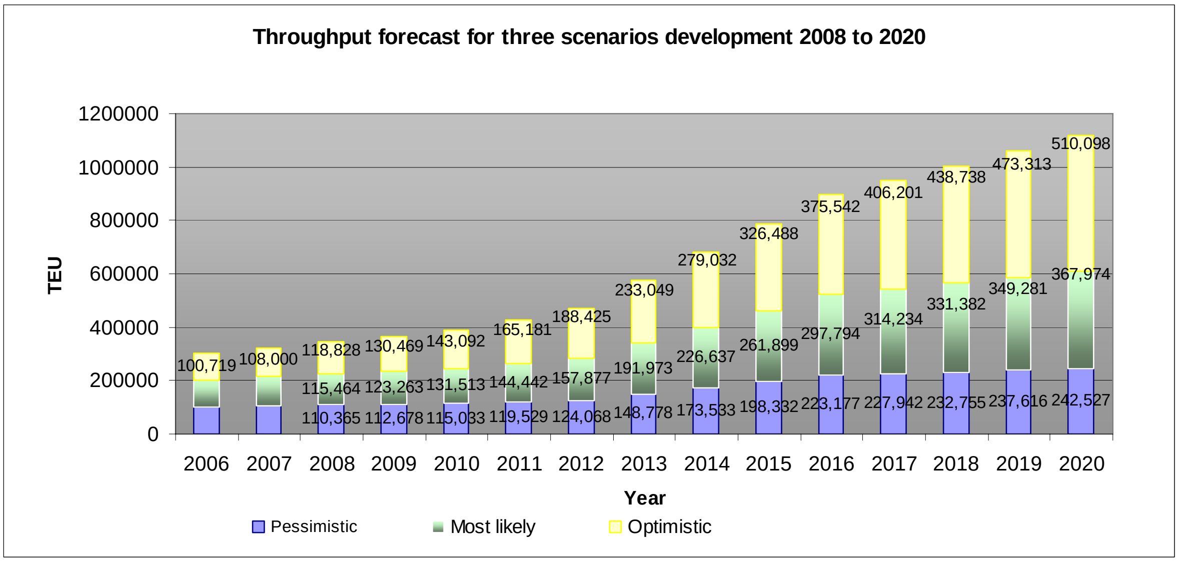


Figure 18 Throughput forecast for three scenarios 2008 to 2020 including component 1,2 and 3

Source: Author's own calculation derived from various source

6.8 Conclusions

This chapter aims to provide estimate of throughput from 2008 to 2020 for determination of optimum number of berths. Various assumptions have been made and different influential factors were thoroughly investigated and future industrial development was also considered. The final figure of throughput is determined based on mostly likely case scenario. This data will be used for investment in berth planning discussed in the next section.

6.9 Berth planning (Determination of optimal number of berth at MCT)

In order to compete MCT should invest in berth planning considering MCT has only one container berth at present. Furthermore, MCT should assess its quay side services in terms of how quickly it can turn ships around at berth. This is important for ship owners to reduce ship time at port in order to reduce its total cost. On the other hand the port should have a sufficient number of berths available at any time to serve the vessels. In the container terminal there is a window and ships follow their schedule in liner shipping. Ships have their time to come to this window at quay to go directly to this berth (Horck, 2008). Furthermore, ports might experience major circumstances which might increase the pressure at quay side if short intervals between ships arrival and peaking period compounded by limited number of berths as in the case of MCT, port congestion is likely to occur.

Case study one is about planning for an optimal number of berths in MCT based on estimated future potential TEU from 2008 to 2020 discussed in forecasting. The aim is to assess and identify from an economic point of view the time line to invest and construct an additional berth. The case study is divided into four main parts (i). introduction (ii). methodology (iii). analysis of result (iv). conclusions. Detailed calculation can be found in Appendix D.

6.9.1 Introduction

For the container terminal the arrival pattern of the ships and berth rate serving vessels varied considerably. Therefore, it is not easy to determine the service capacity in order to minimize the container vessel is turnaround time. Two options can be considered to minimize ship turnaround time of a vessel: either to construct an additional berth or increase service rate in quayside facilities (Kiani et al, 2006). Due to limitation on available data, this paper only aims to assess the minimum number of berths in order to satisfy maximum waiting time. At the same time, the optimization of berth facilities has to be looked at in order to avoid the costly investment of a new berth.

6.9.2 Overview of Muara Container Terminal

The terminal is located in Muara town. In 2000 the container terminal operations became the responsibility of the PSA Corporation Limited terminals from Singapore. The terminal is equipped with 2 Panamax cranes with a 40-tonne lifting capacity each for the handling of containers. The water depth alongside the present 250 meter berth is 12.5 meters.

6.9.3 Methodology

i. Determination of number of berths

Berth occupancy and waiting time are two indicators that can be used to explain the short supply of port services. Congestion can be measured by these two elements. Four input parameters mentioned were considered (see Appendix D). For berth calculations, these parameters are set as variable. A number of alternatives are examined with regard to the number of cranes operating per vessel:

- 1 gantry crane per vessel
- A maximum of 2 gantry cranes per vessel

ii. Queuing theory

This theory makes it possible to calculate the number of service points (berths) through a chosen type of service system (Cariou, 2008). Such a system characterizes the distribution of the arrival pattern and the distribution of the service time of the ships.

Firstly, the total terminal berth utilization (ρ) is determined:

This theory uses the following equations:

$$\rho = \frac{\lambda}{\mu}$$

In which :

ρ = total utilization of terminal [-]

λ = inter arrival time of the ships [hr/ship]

μ = service rate of the ships [hr/ship]

The service rate is the time a ship occupies the berth. The number of berths (n) is found by dividing the total terminal utilization by an assumed number of berths (2,3 or 4). If the outcome for the service system chosen is less than the maximum accepted delay of 10% (Tables 24), then the number of berths is correct.

For utilization values between the values given in Erlang Chart ($E_2 / E_2 / n$) linear interpolation is used to determine the corresponding average waiting time.

$$u = \frac{\rho}{n}$$

In which :
u = berth utilization [-]
ρ = total utilization of terminal [-]
n = number of servers required (berths) [-]

iii. Differential cost of ships and berth

In order to determine the differential ship and berth cost, a ship cost analysis (see Appendix D) and berth investment cost are calculated. Ship cost analysis assumed the ship size of 1,000 TEU vessel as an average container ship size as determined by Drewry Consultant (1997) study for intra-Asian shipping pattern within the East growth region. For calculation of the time charter rate and ship building costs Fearnley (2007) was used. The calculation considers a 20 year period. For the berth investment cost it considers capital cost for infrastructures and work productivity (see Appendix D).

6.9.4 Arrival rate

The expected arrival rate of the ships (container) is based on the assumed shipment volume (defined as the total cargo volume loaded and unloaded during berthing). The maritime overview of maritime development of Asia is used as basis to determine these shipment volumes (Appendix D)

This shows that feeders are to remain the main means of transport. For the reference years in the Table 22, the assumed average shipment volumes are shown for all three scenarios.

Table 22 Average container shipment volume in TEU forecasted up to 2020

Scenario (Average shipment volume in TEUs)	Year		
	2010	2015	2020
Low	150	200	500
Average	250	300	1250
High	500	1000	2000

Existing Scenario (Average shipment volume in TEUs)	Year		
	2005	2006	2007
	253	250	211

Source: Author's own calculation derive from various source

The arrival rate of the ships (λ) can then be calculated as:

$$\frac{cargo \cdot throughput}{averages \cdot shipment \cdot volume}$$

With the above assumptions on the average shipment volume and the container forecast determined in throughput forecast (Appendix D) , the following arrival pattern, Table 23 , has been derived.

Table: 23 - Total ships call at MCT

Ship calls scenario		Year		
		2010	2015	2020
Low	Teu	531	834	256
Average	Teu	531	934	311
High	Teu	531	1074	390

Existing Scenario (Average ship calls)	Year		
	2005	2006	2007
	398	432	477

Source: Author's own calculation derived from various source

6.9.5 Service rate

For each shipment volume, the average terminal handling rate was applied. These rates are estimated in the following:

i. For the container terminal it is assumed that each ship will be serviced by 2 Panamax cranes with an average capacity of 45 moves/hr (see Appendix D). The terminal operator usually claims this rate.

From the above the handling hours (ST) per ship are resultant. Adding to the handling time per ship the hours for berthing and (un)berthing time, 1 hour (0.5 hour berthing and 0.5 hour (un)berthing), gives the total service rate per ship. Other time consuming activities like customs are assumed to be done during the handling period of the ships.

ii. Service system chosen

Systems and maximum acceptable delays for each terminal (see table 24)

Table:24 - Queue system and waiting time criteria

Terminal type	Queue system type	Delay as percentage of the service time
Container terminal	$E_2 / E_2 / n$	10%

Source: Author's own calculation

For container terminal the arrival pattern of the ships is normally according to schedule making the calls regular (E2). The service rate is also more or less regular, because the shipment sizes are assumed to be more or less the same (E2). It is furthermore assumed that the future container operations are conducted from one terminal only.

6.9.6 Result

The average waiting time of the vessels (as percentage of the service time) is calculated for two scenarios (see Appendix D). In each case, a different input is used with regard to the number of cranes per vessel, the number of berths and the distribution function (see Table 25).

Table: 25 - Average service time, berth occupancy rate and waiting time

Vessel				$E_2 / E_2 / n$
n berth (2011)	Number of crane	Average service time (hr)	Utilization	Waiting time (% service time)
1 berth	1 (scenario 2)	11	0.75	138%
	2(scenario 1)	5	0.36	19.4%
2 berths	1(scenario 2)	11	0.38	5.7%
	2(scenario 1)	5	0.18	1%

Source: Author's own calculation

6.9.7 Analysis

i. Arrival time

An Erlang-2 distribution for the inter-arrival time is more suitable as container vessels are expected to follow a scheduled arrival program.

ii. Service time

By large variation from the average value assumed for the service time of the vessels (derived from the average throughput per vessel) the service time will increase and thus the tolerated waiting time (percentage of the service time). For this reason, it is expected that an Erlang-2 distribution function-less conservative- could lead to more practical results and will be applied for the service time of the vessel.

iii. Vessel

A minimum of two berths will be required. The results given in Table 25 show that when choosing for 2 berths with 1 and 2 crane each, the expected waiting time is 5.7% and 1% respectively. The waiting time to be expected by the berth with 2 gantry cranes does not exceed the limit of 10% (normally accepted percentage from various literatures) (see Table 25).

6.9.8 Conclusions and recommendations

i. Conclusions

The trend in the future will be bigger vessels calling at MCT on a regular basis as indicated on the port performance indicators. This study assumed that the vessels followed random pattern arrival but in reality it is not the case. In such case, if many vessels arrived at peak time at any given time, it increases the peaking factor. Therefore, berth congestion is likely to occur which causes an increase in vessels total time in port. The increase in service time and waiting time are contributing factors for the increase of ship turnaround time (Kiani, 2006). The short term solution is for the terminal operator to increase the service rate at the quayside. However, general rules stipulate that once 30% berth occupancy is reached for one berth terminal, it is necessary to build an additional berth. On the other hand, increasing service rate means an increase in operating costs for the port operator, such as increase in gang size, over time and more pieces of machinery are employed. In the long run, this may not be economical.

In order to estimate the optimal number of berths, a queuing theory is used in two different scenarios with the option of either having one berth or two berths. Scenario 2 is to use only the existing berth and to use normal handling operations such as using one quay crane and the same number of gang size. Scenario 1 still uses the existing one berth but increases berth and quay crane capacity in order to reduce ship time at port by reducing the waiting time before loading/unloading and during operations. The study revealed that by increasing the number of berths (applying scenario 2) will reduce the berth occupancy rate to 0.38 and waiting time to an acceptable 5.7%. While applying scenario 1 and improvements it is still possible with berth occupancy rate reduce to 0.18 and waiting time to 1%. In conclusion, based on the above analysis MCT should invest in a new berth in 2011 in order to minimize ship congestion at quayside due to a higher level of inter-arrival rates for ships and higher utilization of quayside equipment. See Table 25.

ii. Recommendations

For scenario 1 a maximum waiting time for vessels, which is less than 10% of the service time, was reached in 2011 by increasing the service rate (operating 2 gantry cranes per vessel at a crane productivity of 45). For scenario 2, berth utilization of 75% is expected in 2011; this exceeds the limit of acceptable 10% delay of service time. Therefore, two cranes operate for one ship is proposed as in scenario 1. A significant reduction of service time was theoretically achieved, from 11 hr to 5 hr.

Based on cost analysis, if investment in a new berth is made during the early period of 2011, the capital cost will be higher than the potential benefit and the saving for the ship owner is less than the port investment cost (Cariou, 2008). In this case, the terminal operator has to maximize productivity of quayside facilities before investing in a new berth in order to save cost.

However, the author's opinion is that, this investment may be economically justifiable if the investment in additional berth is made available in 2017. The differential cost is $365,000.00 (see Figure 19) Figure 19 shows that

(i). Blue - Differential berth and ship costs for having extra 2 berths
(ii). Pink - Differential berth and ship costs for having extra 3 berths
(iii).Yellow - Differential berth and ship costs for having extra 4 berths

This means that if investment in a new berth is made during this period, the capital cost will be higher than the potential benefit and savings for the ship owner are less than port investment costs. However, investment costs were considered the same for all berths in different years, but in reality they will increase accordingly.

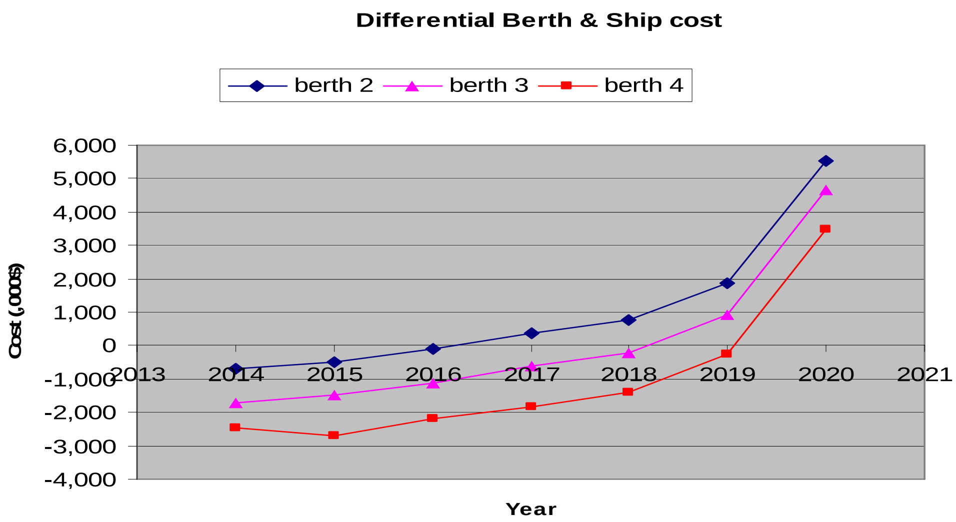


Figure: 19 - Differential berth and ship cost
Source: Author's own compilation derive from various source

When considering investment in an additional berth, back up facilities need to be upgraded so that not to create a bottle neck between the quay transfer area and yard area (Ircha and Crook, 2008). The stacking area requirement were calculated for an anticipated throughput in 2010, 2015 and 2020 for three different scenarios (see Table 26). On berth side two new quay gantry cranes are needed and depending on the land utilization factor the equipment for storage area can be selected.

Table: 26 - Stacking area requirement for anticipated throughput 2010, 2015 and 2020

Required staking ground area (TGS) for container terminal			
Scenario	2010	2015	2025
Low Area(m2)	18,646	35,581	45,531
Medium Area(m2)	18,646	39,847	55,321
High Area(m2)	18,646	45,869	69,463

Source: Author's own calculation derived from Ports Department data

CHAPTER SEVEN

PORT COMPETITION

Chapter seven aims to highlight port competition in the BIMP-EAGA region as well as to identify the type of competition exist in the region, make an assessment and address the weakness on the selected ports. In order for MCT to become a transhipment hub within the region it has to compete with other ports for regional (transhipment) cargo. At the same time this chapter addresses the first objective which is to identify issues that impact on container growth in MCT. Finally, this chapter will be addressing the third objective which is shipping economics and the transhipment market potential for BIMP-EAGA considering MCT.

7.1 Introduction

The BIMP-EAGA region is one of Asia’s growing markets and since its creation in early 1994 overall trading volumes between countries have risen, which, in turn, has placed a greater need on ports to ensure not only good quality infrastructure and equipment but also sufficient container capacity.

The region comprises Brunei Darussalam, Kalimantan, Sulawesi, West Papua and Maluku provinces of Indonesia, Sarawak, Labuan and Sabah in Malaysia and also Mindanao and Palawan in the Philippines and this combined area has a high number of different competing port facilities.

This is also an area that has 50 million people and a high number of ports, although many of these facilities are small and handle mainly breakbulk cargoes. Nevertheless, there is a relatively high number of ports now handling containers. In terms of regional competition, the ports in Appendix E are facilities handling containers within the BIMP-EAGA port region and these are regarded as competing with MCT for containers.

7.2 Definition of port competition

Port competition can be classified into three catergories: intra-port competition, inter-port competition, and intermodal competition (UNCTAD, 1992). Intra port competition where two or more operators are competing within a single terminal results in a high level of cost efficiency but does not offer the flexibility. Another type of competition is inter-port competition. Inter-port competition exerts the most intense pressure because it posseses three different levels of competition, namely competition between ports, competition between areas and competition between ranges (competition between hinterland) (Marlow & Paixao, 2001).

7.3 Literature reviews

This section aims at briefly reviewing literature related to this case study. This would help later when measuring level and type of port competition in the region.
Various elements and methods can be used for measuring port competition in this region. Amongst this literature identified are:

7.3.1 DEA techniques

Song and Yeo (2004) have identified 73 factors (see Appendix F) for port competitiveness based on a survey of 180 ship owners, shipping company executives, shippers, terminal operators, academics and researchers. The five most important criteria for port competitiveness are cargo volume, port facility (infrastructure and superstructure), port location, service level and port expenses. The study revealed that location factors are the most important factors for port competitiveness.

7.3.2 Concentration

Wang and Cullinane, (2004) states that port competition is intensified as a result of an increase in port traffic; therefore, it is important to examine the tendencies towards concentration and deconcentration of port traffic in the container transportation industry. The study used Gini coefficient and HHI to determine the level of concentration of container ports in the Hamburg-Le Havre range and in the U.S east coast and west coast.

Rios and Macada, (2006), analyzed the relative efficiency of container terminals of Mercosur in Brazil using DEA. Appendix G summarises their literature review. Barros, (2006) evaluated the performance of Italian seaports. Efficiency is of major importance and due to increase competition in European seaports, DEA is employed by benchmarking the port performance of other competitors.

7.4 Assessment of regional port competition in BIMP-EAGA region

As highlighted in Appendix E, there is a high number of different ports and terminals located within the BIMP-EAGA region and a number of these are of a low quality in terms of cargo handling and capacities.

The current situation is that these facilities throughout the BIMP-EAGA region are still handling cargo, although it can be assumed that in many instances, this is traffic destined for the local port hinterlands. With such a high number of relatively low quality port facilities, this includes poor quality hinterland logistics and destination very close to the port's location. This is a typical situation in less-developed economies where a high proportion of cargo remains non-containerised and helps to explain why there remains such a high number of competing ports throughout the BIMP-EAGA region.

7.4.1 Strength and weakness of ports in the BIMP-EAGA region

There is clearly a high number of ports in the BIMP-EAGA region, which therefore means that there is a relatively high degree of competition between ports for some regional cargo. Whilst some containers have to be handled at a specific port because

of the ultimate destination/origin of the goods, there is also some cargo that could potentially call at a number of different facilities located within a region.
One part of the assessment process is to analyse the strengths and weakness of different ports and regions and the different areas that comprise the BIMP-EAGA port region. (See Appendix H)

It is clear that there is a lack of infrastructure, insufficient facilities, little spare capacity and lower productivity. Some ports have a strong local cargo base; the majority of containers handled at terminals in Indonesia and Philippines are domestic/intra island cargo, bureaucratic no authority for port development and no plan to increase capacity in the majority of the terminals in the region with the exception of very few ports. Ports that possessed few weaknesses can transform their weaknesses into strengths by developing competitive advantage and strategies.

7.5 Measuring level and type of competition

These sections present what kind of port competition exists in the region and what measurement or tools are used to measure the degree of competition between competing ports. In addition the weaknesses identified in the selected port are addressed. In other words, measures are recommended in order to promote the port more competitive. In order to make assessment on the selected ports, the methodology was first discussed.

7.5.1 Methodology

<u>i. Market concentration</u>

The level of market concentration is measured using Herfindhal Index (H) and Hefindahl Hirschman Index (HHI). (H) is defined as sum of the squared market shares of (n) individual company (Cariou, 2008b). In order to get H and HHI the throughput for all terminals as well as their market share were calculated. If H=1it means that there is monopoly in the market. H=0.5 means duopoly and H=1/n means that the market share is equal. Moreover, if HHI below 1000 it means the market is deconcentrated, if HHI is between 1000 and 1800 it means that the market is moderately concentrated and HHI above 1800 means there is high market concentration.

ii. Measuring port technical efficiency

According Wang, (2004) a firm's efficiency is easily measured by comparing its productivity with that of a firm on the production frontier or cost frontier. An efficient firm can operate on maximum production frontier or a cost frontier. Whilst an inefficient firm operates below the production frontier or above the cost frontier.

The frontier is constructed mainly comprising econometric and mathematical programming techniques. Many studies combine theses distinctions (parametric versus non-parametric). And DEA belong to non-parametric model. To achieve a technical efficiency DMU can either improve output given the same input or reduce input given the same output by improving technology. On the other hand, technical inefficiency is when costs exceed the cost frontier. Another different kind of efficiency is scale efficiency, which is related to a possible divergence between actual and ideal production size. DEA is used to measure technical efficiency (efficiency of container terminal) efficiency of DMU with multiple inputs and/or multiple outputs. The most efficient measurement approach mainly utilises cross-sectional data (data specific for period of time). But recently panel data is used on many occasions because there are several advantages over cross-sectional data despite the computational complexity.

iii. DEA approaches using cross-sectional data

(i). DEA concept in CRS model

Is a mathematical programming to the construction of production frontiers and the efficiency measurement of the constructed frontiers. This model had input orientation and assumed constant returns-to-scale (CRS) Charnes et al, (1978). This model is known as CCR model.

(ii). DEA concept in VRS model

Other studies considered alternative sets of assumptions. Banker et al(1984) introduced the assumption of variable return-to-scale (VRS). When the CCR model is utilized, the estimated production frontiers are defined as efficient and they cannot dominate each other given the condition of variables return-to-scale. The other points enveloped by these points are considered inefficient Wang, (2004).

Data Envelopment Analysis (DEA) was used to evaluate the level of competition between the ports in the region. In technical terms, it means calculation of technical efficiency of a certain amount of input DMU (decision making unit), such as berth length, yard stacking area and draught in order to get the amount of output. According to Cariou, (2008) two types of calculation of DEA are considered. Constant Return to Scale (CRS) and Variable Return to Scale (VRS). CRS assumes that input and output have the same proportion so when increasing a certain unit of input it will increase a certain unit of output proportionally. While CRS assumes that by increasing number of input the output does not increase proportionally since it considers economies of scale. The port is considered technically efficient if the CRS and VRS are both equal to 1. Scale efficiency is used to explain if the terminal is less efficient due to being pure technical or scale inefficient.

7.5.2 Ports throughput

In measuring the degree of port competition the first step is to calculate the total throughput. One of the most important elements to assess the ports competitiveness is port throughput (Song, 2004). The data was collected from 2002 to 2007; some data were not published therefore not available for the purpose of calculation. There was an increase of 10.2% of the total container throughput for BIMP-EAGA ports from 2002 to 2007 (Appendix I). This is a small increase considering a six year period and with a population of 50 million. This confirmed with the above statement that break bulk transportation still plays a major role in this region. Ports that handled a higher percentage of throughput seem to have the highest population. These ports are in the Eastern Indonesia, namely Makasar, Samarinda and Bitung, Eastern Malaysia such as Kuching, Bintulu and Sandakan, in Southern Philippines such as Davao, General Santos, Mindanao and Cagayan de Oro. These are high density populated area. In some ports the growth is declining and this could be due to the cargo going to other ports in the region offering better facilities, more efficient and cost incentives to attract shipping lines.

7.5.3 Market share

The next step is to calculate the market share of each port as a percentage from the total throughput of ports in the region (see Appendix J). MCT accounted for 4.4% of the total BIMP-EAGA container market which is relatively small compared to Bintulu 10.3%, Kota Kinabalu 7.6% and Makassar 11.5% from Malaysia and Indonesia respectively. It is clear that there is only a limited number of ports that handled the majority of the cargo, with exception, ports in the Philippines which individually account for 12.2% for Davao, Cagayan de Oro 6.6% and General Santos 4.2%. This is due to a higher volume of domestic cargoes. This shows the market within the region is highly competitive. PSA-MCT suffers a decline in market share in the last three years from 4.7% to 4.4% (between 2005 and 2007). While its nearest competitor Bintulu Port experience a steady increase in market shares in the last three years from 6.8% to 10.3%. This was followed by Kota Kinabalu Port with a growth of 6.8% to 7.5% in 2005 to 2007. However, in terms of terminal operators Sabah Port Authority held more market shares because it operates in three terminals namely Kota Kinabalu, Tawau and Sandakan port(Kota Kinabalu, Sandakan and Tawau belong to Sabah state). They are the top three terminal operators in the last six years because of larger market shares. According to throughput classification based on terminal operators here, overall there is no degree of horizontal integration H can be found in this region (see Appendix K). Most of the operators are local operators based on their respective regions except for MCT which is operated by an international stevedoring company, PSA International. However, there is a local authority that operates all port in their state, such as Sabah Port Authority with a market share of 7.05% in 2005 increasing to 11.06% in 2007. This is also true for eastern Indonesia ports which are owned and operated by PT (Persero) Pelabuhan Indonesia IV with market share of 30.45% increasing significantly in 2007.

7.5.4 Market concentration

The final step is to measure the degree of competition in the market between the firms using H and HHI (see Appendix K). Overall the Herfindahl index for the last five years is below 0.5, which means that there is no duopoly existing in the market. The result in 2002 shows that the Herfindahl index was relatively small (0.0905); however, the trend is increasing over the next five years, ie Herfindahl index is 0.1457. This shows that the degree of horizontal integration is slightly increasing. Another way to explain the degree of horizontal integration is using Hirschman Index (HHI) by looking at the market concentration. In 2005 and 2007 the HHI was above 1000 and this shows that the market is moderately concentrated (see Table 27). It means that a degree of market concentration exists among the terminals in the region. But it is not enough to explain that the competition level in this region started to deteriorate. It could be assumed that the market share of one terminal is bigger than another because they have the capacity to handle more traffic, better handling facilities and are more efficient. This is true in the real situation where the infrastructure of one terminal is much better than the competing terminal within the local region. If looking at PSA International, which operates MCT, it shows that their market share appeared to be slipping down within the BIMP-EAGA market. However, they have long been operating major terminals in the ASEAN market such as Laem Chabang Port in Thailand. Furthermore, PSA has interest in operating extra regional ports such terminals in Indonesia because they offer modern infrastructures facilities. At the same time, there are few examples where the major global terminal operating companies have taken a stake in a facility – Hutchinson Port Holdings has 48% interest in the Koja terminal at Tanjong Periok, Indonesia.

Table:27 - Herfindhal Index (H) and Hefindahl Hirschman Index (HHI) for 2002, 2003, 2004, 2005, 2006, 2007

	2002	2003	2004	2005	2006	2007
Herfindhal Index (H)	0.0905	0.0954	0.0922	0.1362	0.1376	0.1457
Herfindhal Hirschman Index (HHI)	905	954	13	1362	80	1457

Source: Author's own calculation

7.5.5 Measuring port technical efficiency

In order to measure port technical efficiency Data Envelopment Analysis (DEA) is used as it is widely described in literature. Technical efficiency of the ports measures the technical efficiency of each port in the region rather than measuring an individual terminal in a particular port. The DMU consists of terminals/ports in the region. The input in the calculation consists of container yard area (ha), number of gantry cranes and quay length (metre) (see Table 29 in Appendix L). These inputs are factors that contribute to the increase of the output. In this case the output is throughput (TEU) (see Table 29 in Appendix L). By using excel DEA linear programming (frontier software), CRS efficiency and VRS efficiency are generated. This is to measure the scale (0 to 1) in order to benchmark the efficiency of different firms.

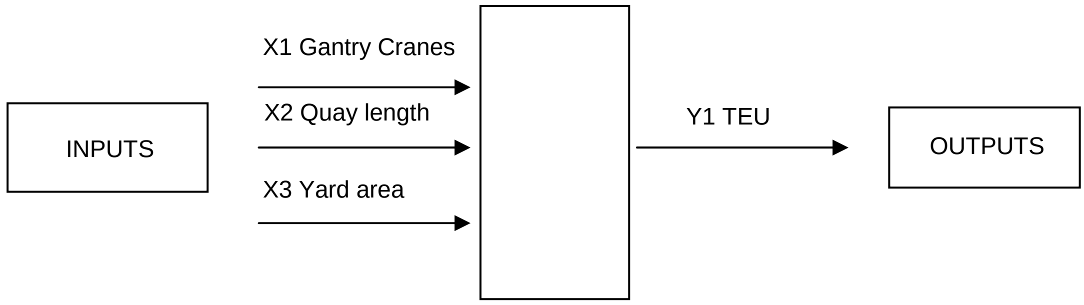


Figure: 20 Final model
Source: Author's own source

Description of final model (inputs and outputs)

(i). X1 and X2 (number of cranes and length of berth) where it is related to the operations and efficiency of berth, the more number of cranes and the longer the berth it is possible to serve the ship faster (Rios & Mecada, 2006). (see Figure 20)

(ii). X3 (terminal area) is related to the efficiency of yard, in the bigger area it is possible to stack more container

(iii). X4 is the number of TEU moved

7.5.6 Model validation

According to Rios and Mecada, (2006) the variables of the models (input and output) can be validated using literature reviews and pilot studies (by sending the model for validation to the operations' manager in the case of Mercosur container terminals in Brazil). In this case the final model was compared with the models used in various types of literature (see Appendix G). Further Pearson correlations were calculated with three inputs. If correlation is less than 0.6, there is no need for variable elimination. (see Table 28)

Table 28 – Pearson correlations

	Number of cranes	Length of berth	Yard area
Number of cranes	1.000		
Length of berth	0.230	1.000	
Yard area	0.379	0.230	1.00

Source: Authors' own calculation derived from various source

The result of DEA for all terminals are shown in Table 31 Appendix L (CRS) and (Scale efficiency). Bintulu, Makassar, Samarinda and Davao are the most efficient terminals. They have achieved the maximum level of utilisation by using their facilities with an efficiency of 1. This means that these ports are pure technically efficient. However, ports that have CRS less than 1 does not mean that they are pure technically inefficient. The VRS need to be found in order to explain scale efficiency. Muara MCT, General Santos, Zamboanga and Balikpapan are relatively less efficient with scores between 0.579 to 0.803; Kuching, Kota Kinabalu, Bitung, Cagayan de Oro, Ambun and IIoilo being the least efficient.

Hence VRS is calculated see Table 31 in Appendix L. The MCT and Balikpapan terminals are now pure technically efficient based on VRS. But this efficiency could be explained due to economies of scale. In order to explain more the scale efficiency can be found by dividing CRS and VRS. The result shows that both terminals have scale inefficiency, MCT (0.784) and Balikpapan (0.803); therefore, they need to increase their throughput. Kuching having the lowest CRS (0.403) mainly due to pure technical inefficieny so they need to increase their size. Bintulu, Makassar and Davao are pure technically efficient.

Table 32 in Appendix L shows the slack in the input factors as a proportion with the output. MCT can be efficient if it increases the output considering that it has the input underutilised, here two gantry cranes. MCT has input slack of 0.26796. The purchase of two gantry cranes is because MCT having in mind an increase of throughput in the near future. In order to efficiently utilize the gantry cranes MCT needs to increase its throughput by attracting more shipping lines calling at MCT. In conclusion MCT is not pure technically efficient but rather scale inefficient. The other elements to explain the port competitiveness namely port tariff, utilisation of port capacity, port infrastructures and port location.

7.5.7 Port tariff

There are factors that MCT can consider in order to attract and retain transhipment traffic such as productivity, equipment, tariff and service flexibility. MCT transhipment rates are competitive compared to benchmarked rates across major transhipment hubs. It is higher than Kota Kinabalu rates because it offers higher handling facilities whereas Kota Kinabalu depends on ship gears for ship operations. However, Bintulu rates are low; they could be highly subsidized by other activities and may not be sustainable in the long run (See Apendix M). MCT has offered Hub shipping lines comparable transhipment rates to Bintulu but has not successfully attracted the lines' entire transhipment business from Bintulu; this confirm the resilience and importance of Bintulu's local cargo base over Muara. Undue restrictions on setting cost-based tariffs may jeopardize port operations and may reduce the attractiveness of port development to private investors (Llanto, 2005).

7.5.8 Capacity Utilization

Capacity is also an important element reviewed in Chapter one. The overall utilisation of port capacity in the BIMP-EAGA region in 2007 was 73.6%. Therefore, supply exceeds demand by 27%. Taking into consideration MCT's superior location and handling facilities, its 43% utilisation still indicates that it has sufficient spare capacity to handle an increase in throughput. This also shows transhipment tariffs will remain very low as shipping lines continue to have ample alternatives (see Appendix N).

7.5.9 Port Infrastructure

Port infrastructure is an important element as reviewed in Chapter one. The facilities are available in a number of different ports within the BIMP-EAGA region (see Appendix O). The terminal handled both general cargo and containers. There are only few ports that use container terminal gantry for ship operations namely Muara container terminal, Bintulu in Sarawak East Malaysia, Makassar in Sulawesi Indonesia, General Santos in Mindanao, Cagayan de Oro, Davao. It is clear that specialized equipment needed for a productive container terminal is not readily available throughout a majority of ports in the region. Therefore, shipping lines moving the containers have to compromise with the type of services and facilities offered by the terminals. Infrastructure facilities offered by MCT are superior among other ports in the region.

7.6 Market potential

The nature of MCT's current, intended facilities and geographical location is such that it can realistically target the market as a transhipment hinterland which includes the Sabah/Sarawak/Federal Territory ports plus possibly Pontianak in Kalimantan. Furthermore, shipping patterns in Brunei, Sabah and Sarawak intra-Asian trades show a strong, orientation towards South Asia, over North and East Asia, because of nationality, currency and locational factors. According to Drewry, (2004) there is a large potential market of main-line intra-Asia sailings, probably around 50 per week passing relatively closely to Muara, but not calling (see Appendix P). Drewry explains the sailing patterns. This is the most realistic targets for inducing new customers to make a call at Muara for transhipment by attracting main-line intra-Asia services sailing directly between Hong Kong and Singapore. Advance Container

Line sails with twice weekly services from Singapore and this could potentially appear to be converted into a transhipment approach – with a hub call at Muara and feeding to Kota Kinabalu, Labuan, Kuching and the like. Moreover, if there is any extension of services to Muara, which can be seen economically viable for carriers, would also, in the vast majority of cases, be equally or more viable at neighbouring ports. The diversion of an existing Singapore-Hong Kong intra –Asia service to MCT may offer the greatest potential for further development and analysis. There are also N/E Asia to SE Asia services currently terminating north of MCT. This can be an opportunity for MCT to attract new customers to make port calls.

7.7 Issues that impact container growth

Of course MCT needs to address some of the difficulties associated with its transhipment operations at MCT. This is true as far as the present situation is concerned, as follows:

(i). MCT cargo volumes are limited and will only support minimal vessel upsize, this is contradicting to the transhipment strategy where the need to have big vessel is essential in order to achieve economies of scale- rationalisation (Moon, 2008b).

(ii). MCT's transhipment tariff is substantially higher than neighboring ports

(iii). MCT has a small cargo base. A sufficient volume of base cargo is necessary in order to attract transhipment operations.

(iv). Sea-Land transhipment to Sabah/Sarawak/Labuan; the common issues are that there are high costs and considerable bureaucratic constraints involved in the intermodal transportation process as highlighted by users.

(v). Small size of local market

(vi)Shipping economics will be explained in the following section.

7.8 Economics of shipping

As highlighted in Chapter one by Baird, (2002) substantial cost saving can be achieved by minimizing deviation distance. Deviation imposes additional marginal costs on vessel operators in the form of fuel, time and port expenses. Time has two elements in this equation: first as the direct extra charge for the additional vessel time added to a round voyage by the deviation, second is in the indirect effect upon vessel scheduling. Therefore, any deviation and introduction of an additional port call will certainly cause some reduction of time/port calls elsewhere in the voyage in order to maintain the fixed day/weekly call pattern. Even though when a new port call offers a reduction in direct costs to a carrier, this is usually not enough, as the call will actually have to compete with other possible scheduling options and offers greater overall benefits than those.

7.8.1 Deviation distance

The location is one of the important elements to be considered in terms of port competitiveness and selection of port transhipment by carriers. See Appendix Q for the deviation distance between ports and the main trade lane Singapore strait to Hong Kong. The smaller deviation distance of MCT and Bintulu from the trade lane in the region that could be a potential market of main-line intra-Asia operators. One of the elements explains why a shipping line call at a particular port is the deviation distance. As observed in Appendix P shows that shipping lines are calling at Sabah and Bintulu (Sarawak); one of the reasons could probably be due to deviation distance as explain in this Table. Sabah and Sarawak have a small deviation distance from the main shipping lane compare to other ports in the region. There could also be other reasons such as this is certainly true as far as individual ports are concerned because volumes are more interesting to carriers. Sabah has 271,000 TEU per annum and Bintulu has around 250,000 TEU per annum and MCT has 110,000 TEU per annum. This could be seen as a major opportunity for MCT to attract new customers, or it could be seen as a sign that carriers are not interested in deviating to Brunei for their relatively low volumes. Therefore, this low local load factor will result in high slot costs as this is not in favor in terms of shipping economics.

7.9 Conclusions

From this analysis it can be concluded that the majority of the traffic are national cargo which has to be handled at specific ports due to the ultimate destination/origin of the goods. This captive cargo is destined for the local port hinterlands. On the other hand, regional cargo (transhipment) could potentially call at a number of different facilities within the region. This could be the only cargo that MCT could potentially contest with. Transhipment is a footloose business in nature. This market is subject to elements, such as where there is a sufficient volume of base cargo, lower transhipment costs, hinterland market due to larger local market and port efficiency. This chapter tried to highlight all these elements and indentify its market potential having in mind that MCT's final objective is to determine the potential for Brunei to serve as a transhipment hub.

Moreover, there is high number of ports in the region, which means that there is a relatively high degree of competition between ports for some regional cargo. The degree of horizontal integration shows that H was increasing from 0.0905 in 2002 to 0.1457 in 2007 this means that the market share is equal. The HHI also increased to 1457 in 2007 which is moderately concentrated. Most operators are from their respective local region operating their own terminals. From the terminal operators point of view there is no element of monopolistic situation as identified in the operators's market share. However, throughput is decreasing in some terminals which explains that competition is intensified, obviously traffic goes to the terminals that offer better facilities and services. The infrastructures are highlighted; some terminals provide good infrastructures and some are having poor infrastructure with lack of modern facilities. This causes total ship time in port to increase due to inefficient handling.

DEA is used in order to find out if the terminals' lack of efficiency are due to pure technical or scale efficiency. The result revealed that some terminals are pure technical inefficient; they need to increase capacity and some terminals are scale inefficient. This is true for MCT, therefore output need to be increased by increasing throughput. In order to increase throughput some impediments that hinder the development of transhipment in MCT, such as small cargo volumes, high tariff, no cargo base, cross-border issues and shipping economics need to be addressed.

CHAPTER EIGHT
CONCLUSIONS

The BIMP-EAGA region is one of Asia's growth markets and since its creation in early 1994 overall trading volumes between countries have risen, which, in turn, has placed greater need on ports to ensure not only good quality infrastructure and equipment but also sufficient container capacity. BIMP-EAGA location is within close proximity to the main shipping trade lanes for mainline services that are transiting Asia with transpacific and/or Europe/Far East/Europe services. They are passing close by Brunei, Sabah and Sarawak without calling. The operators engaged in this business carry a relatively high proportion of international traffic that moves to/from the outlying regions and secondary hubs, such as Manila, Surabaya and Jakarta. From here the cargo connects with further feeder services into regional gateways such as Singapore, PTP, port Klang and to a lesser extent Hong Kong, although some is moved direct on intra-Asia services to China, Japan and South Korea.

The EAST growth area has the market potential to attract these shipping lines to call direct within the BIMP-EAGA region. These direct services will then connect between the BIMP-EAGA region and transhipment hubs, such as Singapore, PTP, Hong Kong and/or Kaohsiung. It makes more economic sense as this will avoid double transhipment costs. There are few ports that have the potential when considering that they are being closed to the main trade lanes in terms of deviation distance. Currently, for instance, most cargo moving out of the BIMP-EAGA region is first shipped to a secondary hub, such as Manila, Tanjung Priok(Indonesia) and/or Tanjung Perak (Indonesia) before being moved onto one of Asia's hub ports and this work out to be expensive. However, the deviation is not the only element to attract shipping lines, there are also other shipping economics to be considered as discussed in the previous chapter.

In terms of geographical location, MCT appears well suited, being located at the northern rim of BIMP-EAGA zone and therefore closer to the main East/West routes and with some of the most modern cargo-handling facilities. There is also considerable competition from other ports in the region, the nearest being Kuching, Bintulu and Kota Kinabalu. Each of these ports is keen to exploit a secondary hub role and it is largely for this reason they are investing in new facilities. They handled big volumes too.

Recognizing the above market potential, MCT is gearing to become a transhipment hub port in the BIMP-EAGA region. Three objectives have been identified in order to realize the above mission as highlighted in the introduction. Chapter two is mainly going through concepts and theories that address the objectives stated. The definition of load centre/transhipment was discussed because there is no clear meaning of those terms. Various factors have been identified to explain why shipping lines call at a transhipment port. These factors are classified from the operator's point of view, shipping lines point of view and the influence of technology- bigger ships.

Chapter three provides a discussion on the trend in Asian markets both in terms of shipping services and development of container ports. In shipping services the Asian container shipping follows the four Asian economic development phases. There are new ports emerging in Asia that intensify port competition. Brunei in terms of geographical position is not in the Asian market but for transhipment it is definitely going to compete with the Asian market. Malaysian ports stress the importance of sufficient base cargo in order to attract transhipment and shipping lines to their port. Chapter two finally concluded with an overall trend in the Asian market.

Chapter four assessed the MCT potential with the objective of transhipment ports in mind both in the present situation and for future developments. In terms of capacity, the current level of capacity at the terminal remains sufficient to be able to meet the needs of regional container shipping lines and shippers both now and in the future. Although the number of containers handled at MCT continues to grow with an average year-on-year growth of over 10% on 2007, and expects this trend to continue in 2008, with further growth of in excess of 10% this is small in comparable with its nearest neighbouring ports. This chapter also explained that there is shipping connectivity between MCT and gateway hubs, such as Singapore, PTP, port Klang and Hong Kong that makes MCT potential and has the possibility to extend its shipping services provided it has high a load factor. These vessels are calling on a weekly basis.

Chapter five aimed at identifying the potential for MCT to compete with other ports in the region. In order to help KPI is needed. Moreover, KPI will give ideas about the situation of MCT compared to other ports. In this assessment ship's time in port indicators and berth indicators are focussed on. These factors will reflect MCT productivity and service efficiency, which is within its control. By examining the port indicators for the last four years the tendency of the vessel calling at MCT could be assessed in terms of average number of vessels, size, and number of containers it carries and BOR. The trend is that the average number of vessel is increasing, average waiting time is decreasing but service time is increasing which explains that bigger vessels call at MCT require more service time. MCT should therefore increase its productivity at the quayside by putting more resources, such as service the ship using two gantry cranes, increase gang size in order to increase service rate. This will increase its competitiveness in terms of service level.

Chapter six investigated the potential for MCT to become a future transhipment hub in the region. There are various conditions for this to happen; first, the potential future demand and then their implications in terms of port investments. This chapter estimated the future throughput by establishing the relationship with the GDP of Brunei. There seems to be a strong correlation on the data set. The medium term projection was considered. Three scenarios were considered pessimistic, most likely and optimistic to reflect an uncertainty period which seems to be realistic. In the estimate other influential factors were considered which cause the increase in throughput in the next twelve years such as industrial development which are likely to be anticipated in the next five years. The final aim is not about forecasting, in order to compete berth planning needs to be invested in. The previous chapter gave an idea about the situation of MCT berth. But it needs to be established when it will be economically viable to invest in a berth as the capital cost is high. Therefore a cost analysis was done to reflect this. Using the queuing theory to determine the optimal number of berth, it is clear that an additional berth is required in 2011 due to an increase in berth utilisation rate. The average number of ship calls is also increasing; therefore an increase in inter-arrival rate. If ships arrive during peak time and increase in inter-arrival rate, it increases the peaking factor; therefore, berth congestion occurred. This result in an increase in ship total time in port. The ideal time was adjusted to make investment so that ship owners will not get too many benefits at the expense of the operator's cost.

Chapter seven discussed port competition between ports in the region. It is important to assess the level of MCT competitiveness relative to other ports; and what type of competition exists in the selected region. Once again, various elements and tools were used to assess the level of port competition. Among the elements considered were to assess the strengths and weaknesses of the terminals in the region. From the findings, it was found that MCT has modern facilities at its disposal comparable to other larger terminals; it has the capacity to handle present local and foreign cargo; it has efficient productivity (PSA operator); in contrast, its port tariffs on transhipment cargo are relatively higher than its competitors and low load factor and low volume of cargo base. In general throughput in the BIMP-EAGA region is increasing with an average growth of 10% in the last six years. This explains that break-bulk cargo is still dominant for shipping in this region. MCT has a year-on-year growth of more than 10%. Another interesting finding is some terminals are decreasing in throughput. They are loosing their market share to more modern equipped port facilities. The reasons are that there are few terminals that have poor infrastructure facilities that depend on ships' gear for unloading containers. This is not what shipping lines want to have especially in this prevailing freight market situation. Although there is no element of a monopolistic situation as H/n means equal share by all terminals, the HHI index shows the market is moderately concentrated. Further, technical efficiency of the selected ports were measured. There are two efficient ports, Bintulu being the nearest MCT competitor and Davao in the Philippines. The result revealed that MCT is scale inefficient; therefore, the output needs to be increased by increasing throughput. This shows that capacity utilization of MCT is low compared to other ports. MCT is equipped with modern facilities capable of handling more throughputs. There is a great market potential in the BIMP-EAGA region considering that there are connectivity with intra-Asian services. East growth area can become a secondary hub between main gateways, such as Singapore, PTP, port Klang, China and Hong Kong. (see Figure 21)

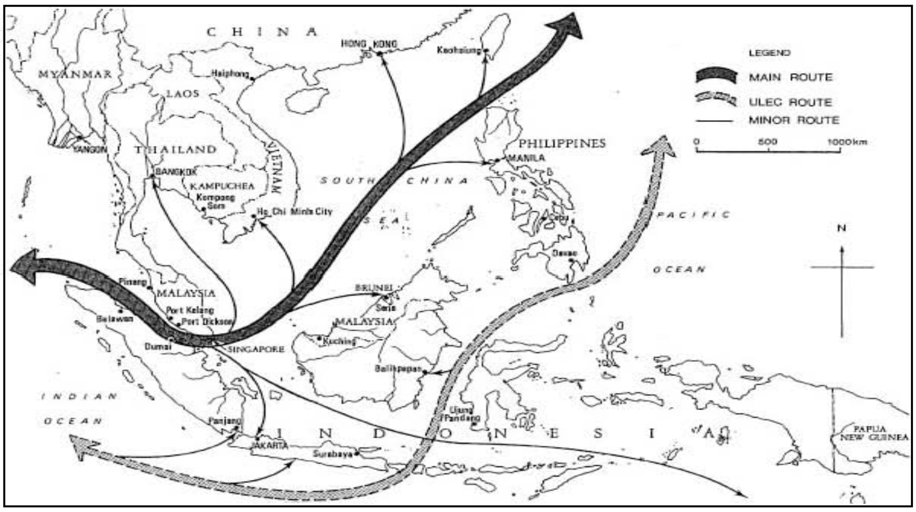


Figure: 21 – Main shipping trade lane for intra-Asian services
Source: Meyrick, (1998)

References

ASEAN Secretariat, (2008). Electronic references. Retrieved March 19, 2008 from world wide web:
http://www.aseansec.org/

Aversa, R., Botter, R. C., Haralambides, H.E. and Yoshizaki (2005). A mixed integer programming model on the location of a hub port in the East Coast of South America. *Maritime Economics and Logistics,* 7, 1-18.

Alderton, P. (1999) *Port Management and Operations*, London: LLP.

Baird, A.J (2001). A new economic evaluation of the Hubport versus Multiport strategy. In *Proceedings of IAME Conference*, The Hongkong Polytechnic University, Hongkong.

Baird, A. J. (2002). The economics of transhipment. In Grammenos, C (ed). *The handbook of Maritime Economics and Business.* London and Hongkong: Lloyd of London press, Chapter 36, pp 832-859.

Brunei Economic Development Board, (2008). Electronic references. Retrieved March 1, 2008 from world wide web:
http://www.bedb.com.bn

Barros, C. P. (2006). A benchmark Analysis of Italian seaports using Data Envelopment Analysis. *Maritime Economics and Logistics,* 8, 347-365.

Banker, R. D., Charnes, A. and Cooper, W. W., (1984), Some Models for Estimating Technical and Scale Inefficiencies in Data Envelopment Analysis. *Management Science*,30, 2, 1078-1092.

Brudirect, (2008). Zero tariff on car parts. Retrieved March 22, 2008 from world wide web:
http://www.brudirect.com/DailyInfo/News/y2k/July08/050708.htm

Cariou, P. (2008a). *Port performance indicators and analysis* . Unpublished lecture handout, World Maritime University, Malmö, Sweden.

Cariou, P. (2008b). *Port economics II- port competition* . Unpublished lecture handout, World Maritime University, Malmö, Sweden.

Charnes, A., Cooper, W. W. and Rhodes, E. (1978), Measuring the Efficiency of Decision Making Units. *European Journal of Operational Research*, 2,429-444.

Chou, M., Goh, M., Song, M., and Teo, C.P. (2004). Value of transhipment hub in sea freight inventory-routing problems. Retrieved March 15, 2008 from the world wide web:
http://ww.bschool.nus.edu.sg/Staff/bizteocp/transhipment30062004.pdf

Coulter, Daniel Y. "The Rise of Hub Ports," in *Globalization and Maritime Power*. edited by Tangredi, Sam J. Washington D.C.: National Defense University Press, 2002.

Cullinane, K.P.B and Khanna, M. (1999). Economies of scale in large container ships, *Journal of Transport Economics and Policy*, 33(2). 185-208.

Cullinane, K., Cillinane, S., and Wang, T. F. (Eds.). (2005). A Hierarchical Taxonomy of container ports in China and Implications for their development. *World Shipping and Port Development*. New York, Palgrave Macmillan.

Cullinane, K. (2000). The competitive position of the port of Hong Kong. *The Journal of the Korean Association of Shipping Studies*.31.45-61.

Cullinane, K. (2000) The competitive Position of the Port of Hong Kong, *The Journal of the Korean Association of Shipping Studies*, 31, 45-61.

Cullinane, K., Khanna, M., and Song, D.W. (1999). How big is beautiful: Economies of scale and the optimal size of containership. In *Proceedings of IAME Conference liner shipping: What's next?*. Halifax, 108-140.

Chou, C. C. (2007). A fuzzy MCDM method for solving marine transhipment container port selection problems. Retrieved March 22, 2008 from world wide web:
www.elsevier.com/locate/amc

CIA World Factbook, (2008). Electronic references. Retrieved March 19, 2008 from world wide web:
http://www.cia.gov/library/publications/the-world-factbook/index.html

Cullinane, K., Yap, W. Y. and Lam, J. S. L. (2007). The port of Singapore and its governance structure.*Transportation Economics*, 17,285-310

Chen, T. (2007). Asian container ports: Development, competition and co-operation. In K. Cullinane & W. S. Dong (Eds.), *Kaohsiung: pending direction* (97-112). New York: Basingstoke Hampshire: Palgrave Maxmilan

Daniel, Y. C. (2002). The rise of hub ports. In S. J. Tangredi (Eds), *Globalization and Maritime Power*. (pp. 133). Washington D.C, National Defense University Press.

Damas, P. (2001). Tranship or direct: a real choice?. American Shipper. 43,6, p56-60June

Department of economic planning and development Brunei Brunei Government information on Brunei, *Electronic references*. Retrieved March 1, 2008 from world wide web:
http://www.depd.gov.bn

Drewry Consultants, 1997
'Short Sea Container Markets, The Feeder and Regional Trade Dynamo', *Drewry Consultants Ltd.,*1997.

Drewry Shipping consultant. (2004). Muara Container Terminal market study. Unpublished report. Brunei Darussalam.

Escap, (2005). Regional shipping and port development strategies Monograph series on managing globalization, United Nation. New York

Frankel, E.G. (2002). The challenge of container transhipment in the Caribbean. *International Association of Maritime Economist Conference.* Panama.

Foggin, J. H. and Dicer, G. N., (1985). Disappearing hinterlands: The impact of the logistics concept on port competition. *Journal of the transportation research forum, 26*(1), 385-391.

Fearnleys Monthly Report (2007). Time charter rates and ship building cost, August, 10

Guy, E. and Urli, B. (2006). Port selection and multicriteria analysis: An application to the Montreal-New York alternative. *Maritime Economics and Logistics,* 8, 169-186.

Hayut, Y. (1981). Containerization and the load center concept. *Economic Geography, 57.* 160-176.

Hormer, M. and O'Kelly, M. (2001) Embedding Economies of Scale Concepts for Hub Network Design, *Journal of Transport Geography*, 9 (4), 255-65.

Hayuth, Y. (1987) *Intermodality: Concept and Practice*, London: LLP.

Horner, M.W. & M.E. O'Kelly (2001). Embedding economies of scale concepts for hub network design. *Journal of Transport Geography,* 9, 255-265.

Hui, G. and Notteboom, T. (2004). Proceeding the first international conference on logistics strategy for ports (ICLSP) Horck, I. (2008). Port technology. Unpublished lecture handout, World Maritime University, Malmo, Sweden.

Imai A. , Zhang J. T. , Nishimura E and Papadimitriou (2007). The berth allocation problem with service time and delay time objectives. *Maritime Economics and Logistics*,9,269-290.

International Monetary Fund, *Electronic references*. Retrieved March 1, 2008 from world wide web:
http://www.imf.org/external/index.htm

Inamura, H., Shibasaki, R. And Ishiguro, K. (2007). Asian container ports: Development, competition and co-operation. In K. Cullinane & W. S. Dong (Eds.), *Kobe:One of the most developed ports in Japan* (62-94). New York: Basingstoke Hampshire: Palgrave Maxmilan

Ircha, M. C. and Crook, G. (2008). Port Management and Analysis. Unpublished lecture handout, World Maritime University, Malmo, Sweden.

Jung B. M. (2007). Trend of container ship growth and port industry market structure change. *Nuri symposium*, Korea. Khalid, N. (2005). The impacts of cargo trends on terminal developments in Asia. In proceeding of 3rd ASEAN Ports and Shipping conference, Surabaya, Indonesia.

Kiani M. , Bonsali S. , Wang J. and Wall A., (2006). *A Break-Even Model for Evaluating the Cost of Container Ships Waiting Times and Berth Unproductive Times in Automated Quayside Operation, 2006.* WMU Journal of Maritime Affairs, 2006, Vol. 5, No.2, 125–126

Lirn, T. C., Thanopoulou, H. Beynon, M.J and Beresford, A.K.C. (2003). Transhipment port selection and decision making behaviour: Analysing Taiwanese case. *International Journal and Logistics Research*, 6(4), 229-244.

Lirn, T. C., Thanopoulou, H. Beynon, M.J and Beresford, A.K.C. (2004). An application of AHP on transhipment port selection: Global perspective*. Maritime Economics and Logistics,* 6, 70-79.

Lloyd's Register-Fairplay, (2008). Distance tables. *Fairplay world shipping encyclopedia* (electronic source). Coulsdon Surrey, UK: Author.

Lloyd's Register-Fairplay, (2008). Ships. *Fairplay world shipping encyclopedia* (electronic source). Coulsdon Surrey, UK: Author.

Lee, S. Y., Chang, Y. T. and Lee, P. T. W. (2007). Determinant of port selection: Heterogeneity among major market players. In *Proceedings of IAME Conference*, Hongkong, 1-13.

Lam, J.S.L and Yap, W. Y. (2007). Competition for transhipment containers by major ports in Southeast Asia: Slot capacity analysis. In *Proceedings of International Conference on Logistics, Shipping and Port Managemen.*

Leong, C. H. (2007). Asian container ports: Development, competition and co-operation. In K. Cullinane & W. S. Dong (Eds.), Tanjung Pelepas:the future regional hub (149-179). New York: Basingstoke Hampshire: Palgrave Maxmilan

Loo, B. and Hook, B. (2002). Interplay of International, National and Local Factors in Shipping container port development: A case study of Hong Kong, *Transport* Reviews,22,2,219-45.

Llanto, G. M., Basilo, E. L. and Basilo, L. (2005). *Competition policy and regulation in ports and shipping*. Unpublished report. Philippines Institute for Development studies.

Malchow, M.B. (2001). *An analysis of port selection.* Umpublished Phd's thesis, University of California, Berkeley, USA.

Malchow, M. and Kanafani, A. (2001). A disaggregate analysis of factors influencing port selection, *Maritime Policy and Management*, 28(3), 265-277.

Malchow, M. and Kanafani A. (2004) A disaggregate analysis of port selection, *Transportation Research Part E,* 40, 317–337.

Makridakis, S. G. and Wheelwright, S. C. (1987). A handbook of forecasting: a manager's guide (2nd ed). New York: John Wiley & Sons.

Magala, M. and Sammons, A. (2008). A new approach to port choice modeling. *Maritime Economics and Logistics,* 10, 9-34.

Ma, S. (2008). *Shipping and port marketing and port pricing*. Unpublished lecture handout, World Maritime University, Malmo, Sweden.

Marlow, P. B. and Paixao, A. C. (2001). Agility, a key enabler in port competition. In proceeding of IAME, the International Association of Maritime Economists Annual conference (pp. 102-114). Hong Kong: Department of shipping and transport logistics, Polytechnics University.

Meyrick, S. J. (1998). Development in Asian maritime trade. *Institute on global conflict and cooperation policy paper no.33*.

Moon, D. H. S. (2008). Policy and technical development of Port. Unpublished lecture handout, World Maritime University, Malmo, Sweden.

Ng. K. Y., (2006). Assessing the attractiveness of ports in the North European Container Transhipment market: An agenda for future research in port competition. *Maritime economics and Logistics, 8,* 234-250.

Notteboom T.E. (2004). Container shipping and ports:Overview. *Review of networks economics*,3, 86-103.

Notteboom, T.E. (2004). Container Shipping And Ports: An Overview. *Review of Network Economics, 3,*86-103.

O'Mahony, H. (Ed.). (1998). Opportunities for container ports: *A cargo systems report.* London, IIR Publications Ltd.

Olaru, D. and Haji Hallid. Dk. S. H. Pg. (2004). Optimizing Muara port's operations using genetic algorithms and simulation. In *Proceedings of IAME Conference*, Dokuz Eylul University, Turkey.

Ports Department Brunei Darussalam, (2008). Electronic references. Retrieved March 19, 2008 from world wide web: http://www.ports.gov.bn

Park, Y. A., Anderson, C. M. and Choi, Y. S. (2006). A strategic model for of competition among container ports in Northeast Asia.

Rios, L. R. and Macada, A. C. G. (2006). Analysing the relative efficiency of container terminals of Mercosur using DEA. *Maritime Economics and Logistics,* 8, 331-346.

Ryoo, D.K. Thanopoulou, H.A. (1999). Liner Alliances in the globalization era: a Strategic tool for Asian container carriers, *Maritime policy and management*, 26 (4), 349-367.

Ryoo, D. K. and Hur, Y. S.(2007). Asian container ports: Development, competition and co-operation. In K. Cullinane & W. S. Dong (Eds.), *Busan:the future logistics hub of Norteast Asia* (34-33). New York: Basingstoke Hampshire: Palgrave Maxmilan

Stopford, M. (2001, January). A new revolution. Containerisation International, 46-48.

Song, D. W. and Yeo, K. T. (2004). A competitive analysis of Chinese container ports using the Analytic Hierarchy Process. *Maritime economics and Logistics, 6,* 34-52.

Song, B. L.(2007). Asian container ports: Development, competition and co-operation. In K. Cullinane & W. S. Dong (Eds.), Shanghai*:Newly and rapidly developing port* (11-33). New York: Basingstoke Hampshire: Palgrave Maxmilan

Tzong, J. (2001). Key success factors for transhipment hubs: the case of the port of Singapore. In *Proceedings of IAME Conference*, Hongkong, 85-100.

Tiwari, P. Itoh, H and Doi, M. (2003). Shippers' port and Carrier selection behaviour in China. A discrete choice analysis. *Maritime economics and Logistics, 5,* 23-39.

Tzong, J. (2001). Key success factors for transhipment hubs: the case of the port of Singapore. In *Proceedings of IAME Conference*, Hongkong.

Tao, C. (2005). The emergence of the Yangtze river delta and the responses of Busan and Kaohsiung. *Journal of International Logistics and Trade*, 3, 35-44.

UNCTAD, (1992). Port marketing and the challenge of the third generation port. Geneva: Author.

Ugboma, C. Ugboma, O and Ogwude, I.C. (2006). An analytic hierarchy process (AHP) approach to port selection decisions – Empirical evidence from Nigerian ports. *Maritime Economics & Logistics, 8,* 251-266.

Woo, L. T. and Wook, S. D. (Eds.). (2005). A New Paradigm for Hub Ports in the Logistics Era. In Woo Lee T. & Cullinane K (Eds.), *World Shipping and Port Development* (pp. 144-145). New York: Palgrave Macmillan.

Wijnolst, N. (2000). Ships, larger and larger: containerships of 18000 TEU - impacts on operators and ports. *Dynamar Liner Shipping 2020 Workshop, London.* 13-29.

World Development Indicators database, (2008). Electronic references. Retrieved March 1, 2008 from world wide web: http://devdata.worldbank.org/home.asp

Wang, T. F. and Cullinane, K. (2004) Industrial competition in container ports. Retrieved April 3 2008 from the World Wide Web: http://www.accc.gov.au/content/item.phtml?itemId=757252&nodeId=96172e3b0c019537427444c2a1e0e519&fn=Breakout%20session%201%20Shipping%E2%80%94Kevin%20Cullinane%E2%80%94IAME2004.pdf

Wang, J. J. and Slack, B. (2000). The evolution of a regional container port system: the Pearl River Delta. *Journal of transport geography*,8,263-275.

Wong, P. (2007). Asian container ports: Development, competition and co-operation. In K. Cullinane & W. S. Dong (Eds.), *Hong Kong:Asia world port* (113-126). New York: Basingstoke Hampshire: Palgrave Maxmilan

Wang, T.F., (2004). *Analysis of the container port industry using efficiency measurement (electronic source): a comparison of China with its international counterparts*. Unpublished Ph.D thesis, Hong Kong Polytechnic University, Department of Industrial and Systems Engineering, Hong Kong.

Appendices

Appendix A – The current shipping activities inside and outside the BIMP-EAGA

Operator	Service name	Vessels used (number used and teu capacity)	Annualised capacity (teu)	Frequency	Service	Ports of call
Advance Container Lines/PIL	BES	2 x 324/312	33,072	3.5	Feeder	Singapore, MCT, Labuan, Singapore, MCT, Kota Kinabalu, Singapore
Advance Container Lines/PIL	KSS	1 x 258	13,416	7	Feeder	Singapore, Kuching, Sibu, Singapore
APL	BGO	2 x 1,078	56,056	7	Feeder/local	Kaohsiung, Subic Bay, Manila (North & South Harbours), Batangas, Bugo, Cagayan de Oro, Davao, General Santos, Manila, Subic Bay, Kaohsiung
APL	MNX	1 x 1,538	79,976	7	Feeder	Kaohsiung, Manila, Cebu, Manila, Kaohsiung
APL.PEL/RCL	SP2			7	Feeder	Singapore, Davao, General Santos, Cebu, Singapore
CT Navigation		1 x 500	26,000	7	Feeder	Kaohsiung, Manila, Cebu, Kaohsiung
Eastern Shipping Lines		4 x 224	11,648	7	Local	Yokohama, Nagoya, Kone, Osaka, Manila, Cebu
Evergreen	NSG	3 x 1,038	53,976	7	Local	Bintulu, Taichung, Kaohsiung, Manila, Cebu (alternate sailings), Tanjung Perak, Tanjung Priok, Port Tanjung Pelapas, Singapore, Bintulu
Hub Line		3 x 700/800	38,500	7	Feeder/local	Bintulu, MCT, Hong Kong, Shanghai
Hub Line		1 x 308	16,012	7	Feeder	Penang, Port Klang, Pasir Gudang, MCT, Kota Kinabalu
Hub Line		1 x 420	10,920	14	Feeder	Bangpakong, Pasir Gudang, MCT, Bintulu
Hub Line		1 x 319	11,484	10	Feeder	Pasir Gudang, Port Klang, Kuching, Bintulu
Hub Line				7	Feeder	Bintulu, Kuching, Pontianak
Hub Line/PDZ		1 x 100	5,200	7	Feeder	Port Klang/Sibu
Johan Shipping	Intra-Asia	3 x 152/358	7,956	10	Feeder	Port Klang, Pasir Gudang, Singapore, Kuching, MCT, Labuan, Kota Kinabalu, Singapore, Port Klang
Johan Shipping	Intra-Asia	3 x 164/436	14,317	7	Feeder	Port Klang, Pasir Gudang, Singapore, Kota Kinabalu, Sandakan, Tawau, Singapore
Lorenzo Shipping		2 x 205/274	12,454	7	Feeder/coastal	Manila, Cebu, Zamboanga, Manila
Lorenzo Shipping		1 x 300	15,600	7	Feeder/coastal	Manila, Zamboanga, Cotabato, Manila
Lorenzo Shipping		1 x 426	22,152	7	Feeder/coastal	Manila, Davao, Cebu, Manila
Lorenzo Shipping		1 x 300	15,600	7	Feeder/coastal	Manila, Davao, General Santos, Manila

Lorenzo Shipping				7	Feeder/coastal	Manila, Cebu, Cagayan de Oro, Iloilo, Manila
Malaysia Shipping Corp	Loop 3	1 x 372	19,344	7	Feeder/local	Kuantan, Singapore, Pasir Gudang, Port Klang, Bintulu, MCT, Labuan, Sandakan, Tawau, Kuantan
Malaysia Shipping Corp	Loop 1	1 x 382	19,864	7	Feeder/local	Port Klang, Singapore, Pasir Gudang, Kuching, Kota Kinabalu, Kuching, Port Klang
Malaysia Shipping Corp	Loop 2	1 x 376	19,552	7	Feeder/local	Port Klang, Singapore, Pasir Gudang, Kuching, Kota Kinabalu, Bintulu, Kuching, Port Klang
MISC	NPS1	1 x 699	72,696	3.5	Feeder/local	Pasir Gudang, Singapore, Port Klang, Kuching, Pasir Gudang
MISC	NPS2A			12	Feeder/local	Pasir Gudang, Singapore, Port Klang, Kota Kinabalu, Labuan, Pasir Gudang
MISC	NPS2B			12	Feeder/local	Pasir Gudang, Singapore, Port Klang, Kota Kinabalu, Kuantan, Pasir Gudang
MISC	NPS3	1 x 699	18,174	14	Feeder/local	Pasir Gudang, Port Klang, Singapore, MCT, Bintulu, Pasir Gudang
MISC	NPS4	2 x 699	18,174	14	Feeder/local	Pasir Gudang, Singapore, Port Klang, Tawau, Sandakan, Pasir Gudang
MISC	NPS5			7	Feeder/local	Pasir Gudang, Singapore, Sibu, Pasir Gudang
Norwegian Asia Line	Intra-Asia	1/2 x 307	7,982	14	Local	Bangkok, Kuching, MCT, Tanjung Manis, Sandakan, Tawau, Tokyo, Yokohama, Nagoya, Osaka, Kitakyushu, Bangkok
PEL/RCL	South Philippines/RSP2	2 x 1,000??	52,000	7	Feeder/local	Singapore, Davao, General Santos, Cebu, Singapore
Perkapalan Dai Zhun	Kuching-Sibu			7		Pasir Gudang, Singapore, Kuching, Sibu, Pasir Gudang
Sim Swee Joo Shipping		1 x 220	11,440	7		Singapore, Port Klang, Pasir Gudang, Kuching, Sibu, Bintulu, Singapore
Solid Shipping Lines		9 x 223/260	37,610	3		Manila, Davao, General Santos, Cagayan de Oro, Manila
Straits Shipping Pte Ltd	Intra-Asia	1 x 387	20,124	7		Singapore, MCT, Labuan, Kota Kinabalu
Sulpicio Lines		1 x 160	8,320	7	Feeder/coastal	Manila, Zamboanga, Cotabato, General Santos, Manila
Tasman Orient Line/NGPL		3 x 660/1,000	18,552	15	Local	Auckland, Whangeri, Tauranga, Wellington, Taranaki, Tanjung Perak, Tanjung Priok, Manila, Subic Bay, Davao, Auckland
Westwind Shipping Corp		6 x 128/437	10,868	7	Local	Yokohama, Kobe, Osaka, Nagoya, Yawata, Kitakyushu, Manila, Cebu, Davao

Appendix B – Principal liner services to/from ports outside the BIMP-EAGA

Operator	Service name	Vessels used (number used and teu capacity)	Annualised capacity (teu)	Frequency	Service	Ports of call
Advance Container Lines	PPS	1 x 459	47,736	3.5	Feeder	Singapore, Palembang, Singapore
APL/OOCL/RCL	JKT				Feeder	Singapore, Tanjung Priok, Panjang
APL	MNX				Feeder/lo	Kaohsiung, Manila, Cebu, Manila, Kaohsiung
APL	SMR				Feeder	Singapore, Tanjung Emas, Singapore
APL	SP2				Feeder	Singapore, Davao, General Santos, Cebu City, Singapore
Australia Asia Alliance	Triple A (Bight Express)	4 x 2,700	140,400	7	Local	Melbourne, Adelaide, Fremantle, Port Klang, Singapore, Tanjung Priok, Fremantle, Melbourne
Advance Container	JKS/SUR	1 x 853	44,356	7	Feeder	Singapore, Tanjung Perak, Singapore
Advance Container	SS1/SUS	2 x 1,080/1,644	141,648	3.5	Feeder	Singapore, Tanjung Emas, Tanjung Perak, Singapore
Cheng Lie/Yangming Marine	PAS	4 x 1,432/1,687	83,876	7	Local	Moji, Hakata, Busan, Kwangyang, Keelung, Taichung, Kaohsiung, Hong
Cheng Lie/TS Lines/Yangming	China 1	3 x 1,000/1,200	57,200	7	Local	Qingdao, Shanghai, Hong Kong, Manila, Tanjung Priok, Tanjung Perak,
Cheng Lie/Yangming Marine Transport Corp	China 2	3 x 834/1,055	50,180	7	Feeder/lo cal	Ningbo, Shanghai, Xiamen, Hong Kong, Manila, Bangkok, Laem Chabang, Hong Kong, Ningbo
CMA CGM/APL	Sunda Express	7 x 3,000	156,000	7	Local	Hamburg, Zeebrugge, Marsaxlokk, Piraeus, Tanjung Priok, Singapore, Port Klang, Marsaxlokk, Le Havre, Rotterdam, Hamburg
Evergreen	NSB	3 x 1,600/1,643	84,240	7	Local	Kaohsiung, Taichung, Keelung, Hong Kong, Pasir Gudang, Singapore, Penang, Port Klang, Port Tanjung Pelapas, Singapore, Manila, Kaohsiung
Evergreen	SPI	1 x 1,164	60,580	7	Feeder	Port Tanjung Pelapas, Singapore, Tanjung Emas, Tanjung Perak, Port Tanjung Pelapas
Evergreen/Maersk Sealand/New Econ	IN1	2 x 820	42,640	7	Feeder	Port Tanjung Pelapas, Singapore, Merak, Tanjung Priok, Port Tanjung Pelapas
Evergreen/Maersk Sealand	IN2	1 x 802	41,704	7	Feeder	Singapore, Port Tanjung Pelapas, Tanjung Priok, Singapore
Evergreen/Maersk Sealand	IN3	1 x 1,117	58,804	7	Feeder	Singapore, Port Tanjung Pelapas, Tanjung Emas, Tanjung Perak, Singapore
Evergreen/Maersk Sealand	IN5	1 x 844	43,888	7	Feeder	Port Tanjung Pelapas, Singapore, Panjang, Tanjung Priok, Port Tanjung Pelapas
Evergreen/Pendulum Express	LKX	2 x 1,810/1,894	96,304	7	Feeder/lo cal	Kaohsiung, Manila, Laem Chabang, Kaohsiung
Hanjin Shipping/Dongnama	MSS			7	Feeder/lo cal	Inchon, Kwangyang, Busan, Keelung, Hong Kong, Singapore, Port Klang, Belawan, Penang, Singapore, Manila, Inchon

Hanjin Shipping/Dongnama/Heung-A/Mitsui OSK Lines/SinoKor	NKI	4 x 1,800/2,200	104,000	7	Feeder/lo cal	Inchon, Busan, Keelung, Hong Kong, Tanjung Priok, Tanjung Perak, Singapore, Hong Kong, Inchon
Heung-A Shipping/Dongnama	MAS/MSS	3 x 1,552/1,743	86,216	7	Local	Inchon, Kwangyang, Busan, Keelung, Hong Kong, Singapore, Port Klang, Belawan, Penang, Singapore, Manila, Inchon
K Line	Pineapple Express	3 x 1,504/1,728	82,090	7	Feeder/lo cal	Kobe, Osaka, Tokyo, Shimizu, Manila, Tanjung Priok, Singapore, Pasir Gudang, Manila, Tokyo
KMTC/Hanjin Shipping/Sea Consortium	KIS 1	4 x 1,600	83,200	7	Feeder/lo cal	Inchon, Kwangyang, Busan, Hong Kong, Singapore, Tanjung Priok, Hong Kong, Kaohsiung, Inchon
KMTC/Hyundai Merchant Marine/Sea Consortium	KIS 2	3 x 1,600	83,200	7	Feeder/lo cal	Ulsan, Busan, Hong Kong, Singapore, Tanjung Priok, Tanjung Perak, Hong Kong, Ulsan
Maersk Sealand	Taiwan/Philippines	2 x 910/1,346	61,152	7	Feeder	Kaohsiung, Subic Bay, Manila, Kaohsiung
Maersk Sealand/Evergreen/Sea Consortium	Asean 3	1/2 1,100	57,200	7	Feeder	Singapore, Port Tanjung Pelapas, Tanjung Emas, Tanjung Perak, Singapore
MISC/Regional Container Lines	RPJ	1 x 900	46,800	7	Feeder/lo cal	Singapore, Tanjung Priok, Panjang, Singapore
PACC	Jakarta-Pasir Gudan Shuttle	1 x 306	15,912	7	Feeder	Singapore, Tanjung Priok, Singapore, Pasir Gudang
Regional Container Lines	RNT	3 x 1,005/1,597	64,650	7	Feeder/lo cal	Shanghai, Xiamen, Hong Kong, Manila, Bangkok, Laem Chabang, Hong Kong, Ningbo, Shanghai
Regional Container Lines/KMTC/ P&ON	RSR	2 x 740/928	86,736	3.5	Feeder/lo cal	Singapore, Tanjung Emas, Tanjung Priok, Singapore
Regional Container Lines/Pacific Eagle Lines/OOCL	RSP2	2 x 400/450	49,400	7	Feeder	Singapore, Davao City (three sailings a month), General Santos (fortnightly), Cebu, Singapore
Samudera Shipping Line	Jakarta	5 x 660/1,560	195,300	2	Feeder	Singapore, Tanjung Priok, Singapore
NYK (TSK Lines)/Regional Container Lines	APX	2 x 450	23,400	7	Feeder/lo cal	Singapore, Pasir Gudang, Singapore, Bangkok, Laem Chabang, Tanjung Priok, Singapore
NYK (TSK Lines)	Southern Cross	4 x 1,450	75,400	7	Feeder/lo cal	Shimizu, Kawasaki, Tokyo, Yokohama, Nagoya, Kobe, Keelung, Hong Kong, Shekou, Singapore, Jakarta, Port Klang, Shimizu
Wan Hai	JCP	3 x 780/1,158	47,736	7	Local	Osaka, Kobe, Moji, Busan, Ningbo, Shanghai, Hong Kong, Manila, Hong Kong, Shekou, Xiamen, Osaka

Source: Drewry Shipping Consultant, (2004): Muara Container Terminal market study

Appendix C - Ships's time at port and berth occupancy rate (Key Performance Indicators)

Ship's time at port,berth occupancy rate and throughput (Key Performance Indicators)											
Year	Quarter	No of vessels	Average turn around time (hrs)	Average waiting time (hrs)	Average service time (hrs)	Average idle time (hrs)	Total working time (hrs)	Total service time (hrs)	Average productive ratio (%)*	BOR %	TEU
2004	Q1/04	95	39.59	6.15	22.85	0	721.00	721.00	100%	17.59%	19447
	Q2/04	93	57.82	7.67	25.95	0	802.00	802.00	100%	19.84%	25404
	Q3/04	106	62.15	7.33	27.47	0	969.50	969.50	100%	23.29%	27372
	Q4/04	101	51.85	8.05	8.05	0	969.50	969.50	100%	18.44%	25445
2005	Q1/05	107	39.16	7.96	26.56	0	949.10	949.10	100%	23.28%	25259
	Q2/05	96	41.08	7.58	27.95	0	895.15	895.15	100%	23.96%	25900
	Q3/05	96	41.37	7.67	29.11	0	930.65	930.65	100%	24.32%	25613
	Q4/05	99	41.79	7.35	28.18	0	925.27	925.27	100%	23.04%	23946
2006	Q1/06	98	51.15	6.73	28.07	0	907.00	907.00	100%	22.26%	22268
	Q2/06	119	38.62	6.58	27.11	0	1079.50	1079.50	100%	25.90%	24400
	Q3/06	105	44.59	7.45	31.85	0	1105.00	1105.00	100%	27.20%	24296
	Q4/06	110	42.49	5.55	30.39	0	1113.50	1113.50	100%	28.51%	30036
2007	Q1/07	133	35.92	4.38	26.31	0	1166.85	1166.85	100%	27.99%	27310
	Q2/07	122	29.05	2.53	20.67	0	1246.83	1246.83	100%	29.41%	27824
	Q3/07	112	45.28	5.90	33.29	0	1236.15	1236.15	100%	30.26%	27163
	Q4/07	110	28.69	2.75	67.45	0	1148.27	1148.27	100%	29.02%	25705

Source: Author's own calculation derived from Ports Department raw data 2004 to 2007
note: According to prof. Cariou the ratio of productive time and service time can not be 100% because Port can not reach maximum production rate, which is extraordinary. However, because of zero idle time it is true in this case.

Appendix D - Berth calculation

Scenario 1 - Maximum 2 crane operating per vessel

Queuing System

E1/E2/n **8400 hrs/yr** **77% of avg shipment move from/to quay**

															Cost of increasing new berth		
Year	Handling rate	Arrivals	Inter arrival time	Average shipment (Teu)	Moves per ship	Service time	Total service time	No berths	Utilisation	Expected waiting time ratio (E1/E2/N)	Avg waiting time per vessel	Total time in port	Avg daily Ship Cost ($000)	Annual ship cost ($000)	Annual capital cost ($000)	Annual ship cost ($000)	Differential berth and ship cost ($000)
2004	45	395	21	200	154	3	4	1	0.21	0.06	0.27	112.50					
							4	2	0.10	0							
2005	45	398	21	200	154	3	4	1	0.21	0.06	0.27	112.50					
							4	2	0.10	0							
2006	45	432	19	200	154	3	4	1	0.23	0.07	0.31	113.56					
							4	2	0.11	0							
2007	45	477	18	200	154	3	4	1	0.25	0.09	0.40	115.69					
							4	2	0.13	0.01	0.04	96.96					
2008	45	577	15	200	154	3	4	1	0.30	0.13	0.57	119.93					
							4	2	0.15	0.01	0.04	96.96					
2009	45	616	14	200	154	3	4	1	0.32	0.13	0.57	119.93					
							4	2	0.16	0.01	0.04	96.96					
2010	45	526	16	250	193	4	5	1	0.33	0.14	0.74	144.40					
							5	2	0.17	0.01	0.05	121.20					
2011	45	578	15	250	193	4	5	1	0.36	0.18	0.95	149.47					
							5	2	0.18	0.01	0.05	121.20					

2012	45	632	13	250	193	4	5	1	0.40	0.24	1.27	157.07					
							5	2	0.20	0.07	0.35	128.40					
							5	3	0.13	0	0.00	120.00					
2013	45	768	11	250	193	4	5	1	0.48	0.39	0.00	0.00					
							5	2	0.24	0.02	0.10	122.40					
							5	3	0.16	0	0.00	120.00					
2014	45	907	9	250	193	4	5	1	0.57	0.63	3.33	206.47	3,964	818	1,020	818	
							5	2	0.28	0.02	0.10	122.40		485	2,040	485	-687
							5	3	0.19	0	0.00	120.00		476	3,060	476	-1,697
							5	4	0.14	0	0.00	0.01		40	4,265	40	-2,466
2015	45	873	10	300	231	5	6	1	0.64	0.86	5.27	273.79	4,320	1,183	1,020	1,183	
							6	2	0.32	0.03	0.18	151.62		655	2,040	655	-492
							6	3	0.21	0.01	0.06	145.44		628	3,060	628	-1,485
							6	4	0.16	0	0.00	144.00		622	4,265	622	-2,684
2016	45	993	8	300	231	5	6	1	0.72	1.38	8.46	350.34	4,580	1,605	1,020	1,605	
							6	2	0.36	0.04	0.25	153.09		701	2,040	701	-117
							6	3	0.24	0.01	0.06	148.67		681	3,060	681	-1,116
							6	4	0.18	0	0.00	147.20		674	4,265	674	-2,198
2017	45	1047	8	300	231	5	6	1	0.76	1.87	11.47	422.46	5,133	2,169	1,020	2,169	
							6	2	0.38	0.06	0.36	152.64		784	2,040	784	365
							6	3	0.25	0.01	0.06	145.44		747	3,060	747	-618
							6	4	0.19	0	0.00	144.00		739	4,265	739	-1,815
2018	45	1105	8	300	231	5	6	1	0.81	2.2	13.49	471.04	5,595	2,636	1,020	2,636	
							6	2	0.40	0.06	0.36	152.64		854	2,040	854	761
							6	3	0.27	0.01	0.06	145.44		814	3,060	814	-218
							6	4	0.20	0	0.00	144.00		806	4,265	806	-1,415

2019	45	1105	8	300	231	5	6	1	0.81	3.3	20.24	632.96	6,099	3,860	1,020	3,860	
							6	2	0.40	0.09	0.54	156.96		957	2,040	957	1,883
							6	3	0.27	0.01	0.06	145.44		887	3,060	887	933
							6	4	0.20	0	0.00	144.00		878	4,265	878	-263
2020*	45	294	29	1250*	963	21	22	1	0.78	1.87	41.87	1542.15	6,648	10,252	1,020	10,252	
*(increase cranes productivity due to bigger ship)							22	2	0.39	0.06	1.32	559.68		3,721	2,040	3,721	5,511
							22	3	0.26	0.01	0.22	533.28		3,545	3,060	3,545	4,666
							22	4	0.20	0	0.00	528.00		3,510	4,265	3,510	3,497

Additional berth is required in
238 2011 - 238 m
(1.1x2(200+15)+15-
250)=238m

Source: Author's own calculation derived from Ports Department data

Scenario 2 - Maximum 1 crane operating per vessel

Queuing System

E1/E2/n 8400 hrs/yr 77% of avg shipment move from/to quay Cost of increasing new berth

Year	Handling rate		**Inter arrival**	**Average**	Moves	**Service**	**Total service**	No		Expected waiting	Avg waiting	Total	Avg daily Ship	Annual	Annual	Annual	Differential berth
	rate	**Arrivals**	**time**	**shipment (Teu)**	**per ship**	**time**	**time**	berths	Utilisation	time ratio (E1/E2/N)	time per vessel	time in port	Cost ($000)	ship cost ($000)	capital cost ($000)	ship cost ($000)	and ship cost ($000)
2004	20	395	21	200	154	8	9	1	0.41	0.24	2.09	258.91					
							9	2	0.20	0.01							
2005	20	398	21	200	154	8	9	1	0.41	0.24	2.09	258.91					
							9	2	0.21	0.01							
2006	20	432	19	200	154	8	9	1	0.45	0.3	2.61	271.44					
							9	2	0.22	0.01							
2007	20	422	20	200	154	8	9	1	0.44	0.3	2.61	271.44					

							9	2	0.22	0.01	0.09	218.16					
2008	20	577	15	200	154	8	9	1	0.60	0.63	5.48	340.34					
							9	2	0.30	0.02	0.18	220.32					
2009	20	616	14	200	154	8	9	1	0.64	0.8	6.96	375.84					
							9	2	0.32	0.02	0.18	220.32					
2010	20	526	16	250	193	10	11	1	0.67	0.8	8.50	459.00					
							11	2	0.33	0.03	0.33	271.92					
2011	20	578	15	250	193	10	11	1	0.73	1.38	14.66	606.90					
							11	2	0.37	0.06	0.66	279.84					
2012	20	632	13	250	193	10	11	1	0.80	2.8	29.75	969.00					
							11	2	0.40	0.07	0.77	282.48					
							11	3	0.27	0.04	0.44	274.56					
2013	20	768	11	250	193	10	11	1	0.97	~	0.00	0.00					
							11	2	0.49	0.06	0.66	279.84					
							11	3	0.32	0.01	0.11	266.64					
2014	20	907	9	250	193	10	11	1	1.15	~			3,964		1,020		
							11	2	0.57	0.25	2.75	330.00		1,308	2,040	1,308	
							11	3	0.38	0.02	0.22	269.28		1,067	3,060	1,067	-779
							11	4	0.29	0	0.00	264.00		1,046	4,080	1046.42	-1,778
2015	20	873	10	300	231	12	13	1	1.30	~			4,320	0	1,020		
							13	2	0.65	0.41	5.33	439.92		1,901	2,040	1900.66	
							13	3	0.43	0.05	0.65	327.60		1,415	3,060	1,415	-535
							13	4	0.33	0.01	0.13	315.12		1,361	4,080	1361.46	-1,501
2016	20	993	8	300	231	12	13	1	1.48	~			4,709	0	1,020		
							13	2	0.74	0.83	10.79	570.96		2,689	2,040	2688.82	
							13	3	0.49	0.06	0.78	330.72		1,557	3,060	1,557	111

							13	4	0.37	0.01	0.13	315.12		1,484	4,080	1483.99	-835
2017	20	1047	8	300	231	12	13	1	1.62	~			5,133	0	1,020		
							13	2	0.81	1.3	16.90	717.60		3,684	2,040	3683.54	
							13	3	0.54	0.08	1.04	336.96		1,730	3,060	1,730	934
							13	4	0.41	0.01	0.13	315.12		1,618	4,080	1617.55	26
2018	20	1105	8	300	231	12	13	1	1.65	~			5,595	0	1,020		
							13	2	0.83	1.5	19.50	780.00		4,364	2,040	4364.19	
							13	3	0.55	0.08	1.04	336.96		1,885	3,060	1,885	1,459
							13	4	0.41	0.02	0.26	318.24		1,781	4,080	1780.59	544
2019	20	1105	8	300	231	12	13	1	1.65	~			6,099	0	1,020		
							13	2	0.83	2	26.00	936.00		5,708	2,040	5708.36	
							13	3	0.55	0.13	1.69	352.56		2,150	3,060	2,150	2,538
							13	4	0.41	0.02	0.26	318.24		1,941	4,080	1940.84	1,728
2020*	20	294	29	1250*	963	48	49	1	1.72	~			6,648	0	1,020		
*(increase cranes productivity due to bigger ship)							49	2	0.86	2	98.00	3528.00		23,453	2,040	23452.58	
							49	3	0.57	0.02	0.98	1199.52		7,974	3,060	7,974	14,459
							49	4	0.43	0.02	0.98	1199.52		7,974	4,080	7973.88	13,439

Source: Author’s own calculation derived from Ports Department data

Methodology

Number of berth

Berth occupancy and waiting are two indicators that can be used to explain short supply of port services. Congestion can be measured by this two elements. To satisfy the demand with regard to the maximum waiting time, a minimum number of berth should be available.

Approach method

For this exercise the queuing theory will be applied to determine the required number of berths.

Input parameters

Important parameters has to be considered for this calculation to determine the result based on queuing method system.

1. Allowable maximum waiting time

The waiting time of the vessels (as percentage of the service time) depends on the number of berths available and is required to be within the limits

Maximum waiting time for feeder vessels: less than 10% of the service time.

2. Queuing discipline

The First-in-first-out (FIFO) discipline, is suitable for container terminal there will be no need to give privilege to vessels of the same type

3. Production per berth

The production per berth depends on the number of cranes per berth and the net production of the crane per hour. By the calculations of the berth productivity, an average crane production of 20 moves per hour will be assumed in the case of 1 crane operating per vessel. 45 moves in the case of 2 cranes operating per vessel.

4. Distribution functions

The statistical distribution describing the inter arrival and service time of the vessels.
The Erlang distribution function:
The Erlang 2 distribution function gives less conservative results of the expected waiting time.

Container ship size overview

(Drewry Consultants, 1997)emphasised in the following-:

"The maritime pattern in Southeast Asia has resulted in the specific use of certain types of container ships The Asian Short Sea shipping market is characterised by the dominance of Lo-Lo container shipping. The dynamic economic growth of the region is therefore transmitted directly through to containerised shipping flows. Making Asia the largest and fastest growing regional container market in the world."

Currently the container ship size used in the Inter-Asian maritime trade varies between 20 and 1,500 TEU, with an average ship size of 700 TEU. The ships deployed between Thailand and Singapore average currently already 1,000 TEU. For the future these so called feeder ships will increase in size (to between 1,000 and 2,500 TEU), as the Inter-Asian trade is expected to keep on growing. When more cargo is generated in Brunei it becomes more economical for the shipping lines to use these larger container ships on route to Brunei.

Berth investment cost	
Capital cost information	
Investment cost for existing berths (per berth)	$8,000,000
Investment cost for new berths (per berth)	$9,450,000
Annual amortization factor	0.1275
Productivity information	
Average hours worked per day (3 shifts)	24
Days worked per week	7
Average number of days out (dredging and maintenance)	15
Number of days	365
Number of existing berth	1 (250m)
Quay crane	2

Differential berth and ship cost ($000)			
	2	3	4
2014	-687	-1,697	-2,466
2015	-492	-1,485	-2,684
2016	-117	-1,116	-2,198
2017	365	-618	-1,815
2018	761	-218	-1,415
2019	1,883	933	-263
2020	5,511	4,666	3,497

Source: Author's own calculation derived from Ports Department data

Ship cost for 1000 TEUs capacity vessel

Forecast TC 2008-2025 using exponential moving average

Exponential moving average period :	4
Exponential moving average multiplier :	0.40

Forecast data of Charter rates (per day)															
Year	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
(1) Historical data	12,000	12,500	12,500	12,700	12,900	13,000	13,300	13500	13,600	12,000	12,500	12,500	12,700	12,900	13,000
(2) Forecast data								13,125	13,231	12,000	12,500	12,500	12,700	12,900	13,000
Forecast data of Operating expences (per Day)															
Year	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
(1) Past Trend data	2,000	2,100	2,300	2,100	2,200	2,300	2,400								
(2) Forecast data								2,472	2,546	2,673	2,834	3,032	3,275	3,537	3,855
Memo															
	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Time charter rates ($ per day)	13,300	13,125	13,231	11,360	12,700	12,500	12,780	12,980	13,040	13,420	13,580	11,400	12,700	12,500	12,780
Newbuilding prices ($ million)	23.0														
Operating costs ($ per day)	2,400	2,472	2,546	2,673	2,834	3,032	3,275	3,537	3,855	4,202	4,580	4,993	5,442	5,932	6,465
Outstanding loan (year end)	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000						

Average earning p.a	4.529
Average capital employed	15
Scrap value	6.9
***Assume Trading days per year**	355
***Scrap value after 20 years**	6.9
***70% of initial cost loan issued at 5% interest rate for period of 8 years**	
***Risk premium 7.6%**	

Calculation of daily ship cost															
Discount rate	**10.00%**														
		2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Time charter rate/day ($)		13,125	13,231	11,360	12,700	12,500	12,780	12,980	13,040	13,420	13,580	11,400	12,700	12,500	12,780
Earnings p.a.*		4.659	4.697	4.033	4.509	4.438	4.537	4.608	4.629	4.764	4.821	4.047	4.509	4.438	4.537
Capital Receipt	0.0														
Total receipt	0.0	4.659	4.697	4.033	4.509	4.438	4.537	4.608	4.629	4.764	4.821	4.047	4.509	4.438	4.537
Operating costs ($ per day)		2,472	2,546	2,673	2,834	3,032	3,275	3,537	3,855	4,202	4,580	4,993	5,442	5,932	6,465
Ship purchase/sale	25.0														
Operating cost p.a.		0.902	0.929	0.976	1.034	1.107	1.195	1.291	1.407	1.534	1.672	1.822	1.986	2.165	2.360
Principal payments		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0
Interest Payments		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0
Outstanding loan (year end)	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0
Total Expenses	25.0	0.902	0.929	0.976	1.034	1.107	1.195	1.291	1.407	1.534	1.672	1.822	1.986	2.165	2.360

Net Cashflows	-25.0	3.757	3.768	3.057	3.474	3.331	3.342	3.317	3.222	3.230	3.149	2.225	2.522	2.272	2.177
Cumulative cashflows	-25.0	-21.243	-17.475	-14.418	-10.944	-7.613	-4.272	-0.955	2.267	5.498	8.647	10.871	13.394	15.666	17.843
Payback Break Even	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Discounted Cashflows	-25.0	3.416	3.114	2.297	2.373	2.068	1.886	1.702	1.503	1.370	1.214	0.780	0.804	0.658	0.573
Cumulative Discounted Cash Flows	-25.0	-21.584	-18.471	-16.174	-13.801	-11.733	-9.847	-8.144	-6.641	-5.271	-4.057	-3.278	-2.474	-1.816	-1.242
Payback Break Even	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
IRR	**10.29%**														
NPV	**0.40**		**NPV excel**		**0.40**										
NPV Ratio	**0.02**														
Daily ship cost		**2,542**	**2,618**	**2,749**	**2,914**	**3,118**	**3,367**	**3,636**	**3,964**	**4,320**	**4,709**	**5,133**	**5,595**	**6,099**	**6,648**

*Assumed a new building call to the port therefore initial cost is higher as reflected in berth calculation

Source: Fearnley 2007 Time charter rate and ship building cost for 1,000 teus vessel

Remark:
It is assumed the vessel has no outstanding loan and estimated to be in operation upto 2025
Operation cost is based on estimated cost in present shipping market

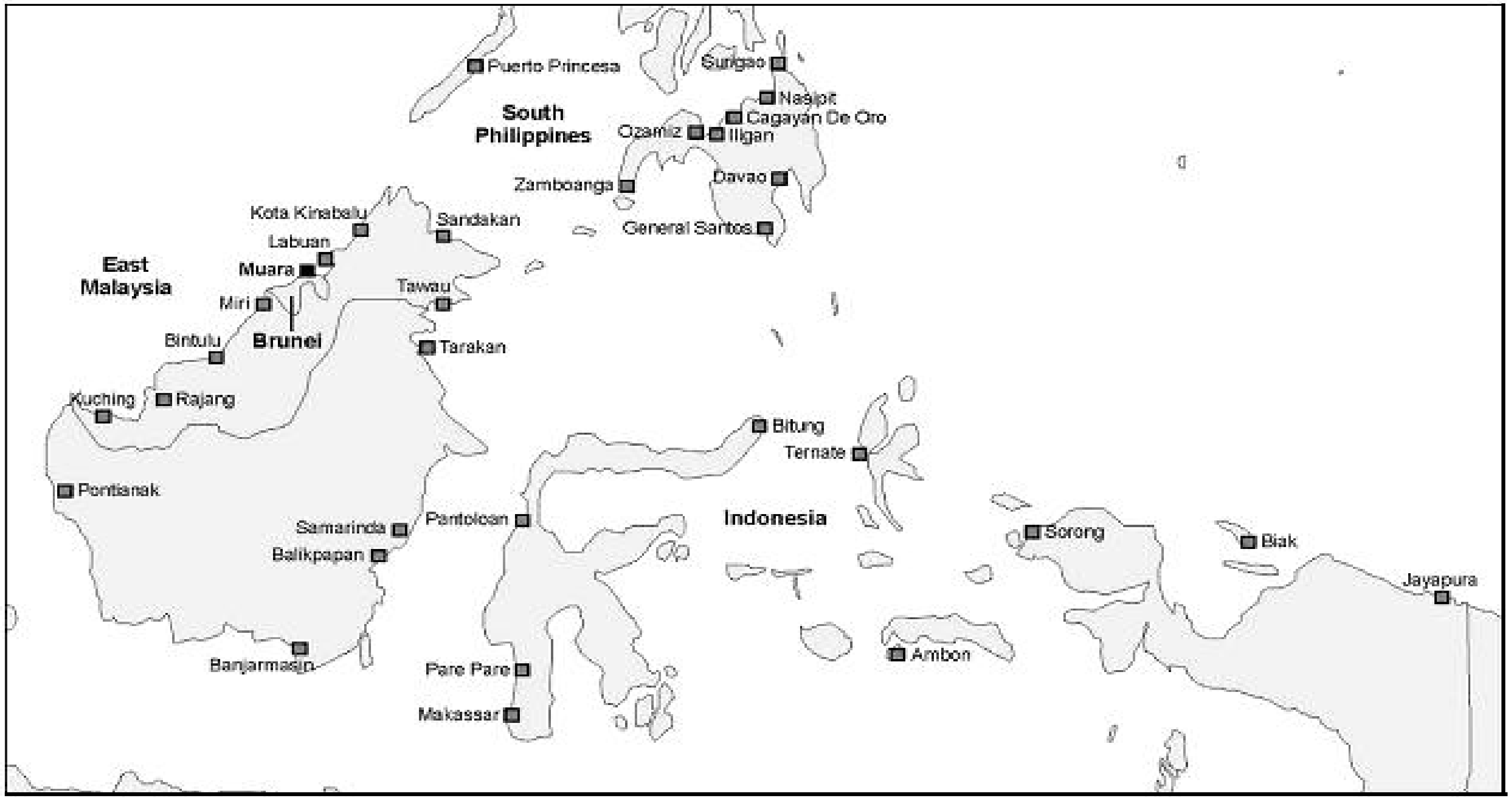
Source: Author’s own calculation derived from various sources

Appendix E - List of competing ports within BIMP-EAGA

Country	Region	Port
East Malaysia	Sarawak	Kuching
		Rajang
		Miri
		Bintulu
	Sabah	Kota Kinabalu
		Sandakan
		Tawau
	Federal Territory	Labuan
Brunei		Muara
Indonesia	Kalimantan	Pontianak
		Samarinda
		Balikpapan
		Terakan
		Banjarmasin
	Sulawesi	Makassar
		Pare-Pare
		Bitung
		Pantoalan
	Eastern Indonesia	Biak
		Ternate
		Jayapura and Ambon
		Sorong
Philippines (South)	Mindanao	Davao
		Cagayan De Oro
		General Santos
	Visayas	LLigan
		Nasipit
		Ozamiz
		Puerto Princess
		Zamboanga
		Surigao

Source: Drewry Shipping Consultant, (2004) Muara Container Terminal market study

Map of BIMP EAGA



Source: Drewry Shipping Consultant (2004) Muara Container Terminal market study

Appendix F - Elements of port competitiveness

List of the elements of port competitiveness	
Application of EDI system	Ability of port personnel
Average hours of port congestion	Port accessibility
Berth/terminal availability	Port congestion
Building port MIS	Port facilities
Capacity of transportation connectivity	Port marketing
Capacity/status of facilities available	Port operation
Cargo volume of handling transhipment	Port operation by government
Changes in social environment	Port operation by local autonomous entity
Changes in transport and cargo function	Port operation by private sectors
Complete preparation of multimodal transport	Port operation by strategies
Concentration of volume by export/import	Port operation time
Customs clearance system	Port ownership
Dredging: yes or no	Port productivity
Easy access to port	Port service
Easy access to port	Port size
Economic scale of hinterland	Port tariff
Effectiveness of terminal operation	Possibility of mutual reference of electronic
Existence of cargo tracing system	computation network
Existence of port hinterland road	Price competitiveness
Existence of terminal operating system	Response of port authorities concerned
Existing pattern of navigation routes	Road network to be fully equipped
Extent of port EDI	Sea transportation distance
Financial factors of port	Securing deep draft
Free time of container freight station	Securing exclusive use of equipment
Frequency of ships calling	Securing fairway
Handling charge of TEU	Securing navigation facilities/equipment
Handling volume of export/import cargo	Securing railroad connection
Inland transportation cost	Status of national economy
Inter-linked transportation network	Sufficiency of berth
Internal politics	Sufficiency of securing information equipment
Loading time	Technical factors of port
Location factors of the port concerned	Terminal facilities
Market position within the area	Trade market
Mutual agreement of port users	Trade/commerce policy
Navigation distance	Transportation distance
Nearness to hinterland	Types of port operation/management
Nearness to main trunk	World business
Number of liners calling at ports	

Source: Song and Yeo, K.T. (2004). Competitive analysis of Chinese container port using the AHP

Appendix G - DEA techniques in ports

Reference	Data description	DEA model	Inputs	Outputs
Roll and Hayuth (1993)	20 ports	CCR	● Manpower ● Capital ● Cargo uniformity	● Cargo throughput ● Level of service ● Users' satisfaction ● Ship calls
Martinez-Budria et al (1999)	26 spanish ports	BCC	● Labour expenditures ● Depreaciation charges ● Other expenditures	● Total cargo moved through the docks ● Revenue obtained from the rent of port facilities
Tongzon (2001)	Four Australian and 12 other international ports	CCR Additive	● Number of cranes ● Number of container berths ● Number of tugs ● Terminal area ● Delay time ● Labour	● Cargo throughput ● Ship working rate
Valentine and Gray (2001)	31 container ports out of the world's top 100 container ports	CCR	● Total length of berth ● Total of investments	● Number of containers ● Total tons throughput
Itoh (2002)	Eight ports of Japan	Window	● Terminal area ● Number of berths, cranes and employees	● TEUs handled
Serrano and Castellano (2003)	Nine ports of Spain	BCC	● Berth size ● Terminal area ● Number of cranes	● TEUs handled ● Total tons throughput
Turner et al (2004)	26 North America container ports	-	● Berth size ● Terminal area ● Number of cranes	● TEU handled
Cullinane et al (2004)	25 of 30 biggest terminals in the world	Window, CCR and BCC	● Berth size ● Terminal area ● Number of berth cranes ● Number of yard cranes ● Number of straddle carriers	● TEU handled
Wang and Cullinane (2006)	104 European container terminals	CCR and BCC	● Total length of berth ● Terminal area ● Equipment costs	● Container throughput

Source: Rios and Macada, (2006) Analysing the relative efficiency of container terminals

Appendix H - Strength and weakness of ports and areas within the BIMP-EAGA region

Country	Region/Port	Strength	Weaknesses
East Malaysia	Sarawak	Bintulu has designated container terminal	All ports and terminals reliant upon ships gear for box moves to/from ship and quay (except Bintulu)
		Bintulu is not reliant upon ships gear for ship-to-shore box activities	Lower productivity than MCT due to lack of equipment
		Bintulu has deepest water at facility of any competing port in the region	All facilities are multi-purpose handling general cargo and containers (with exception Bintulu)
		Pending Terminal at Kuching has designated container facility	Bintulu reportedly has plans to increase container capacity, but has remained unconfirmed for some time
		Region accounted for about 15% in 2002 and 20% of total regional volume in 2007	Questionable whether Bintulu needs additional capacity as utilisation in 2002 is under 60%
		Spare capacity available at all ports in Sarawak	Container handling equipment needs modernising/investment
			Low transhipment stevedoring tariff costs are not sustainable indefinitely, unless being subsidised by other sources of revenue
	Sabah	Region accounted for almost 10% in 2002 and only reach 11% of total regional volume in 2007	Kota Kinabalu has little spare capacity
		Kota Kinabalu tariff vessel costs low	Need to consider investment in container handling equipment
		Container tariff stevedoring rates for both transhipment and local cargo are low	Capacity that is available (Sandakan/Tawau) is not at more desirable facility (ie Kota Kinabalu)
		Some spare capacity available, especially at Sandakan	Container handling productivity lower than at MCT
	Federal Territory	Sufficient capacity for local port hinterland demands	Only consists of Labuan port
		No need expansion of facilities in foreseeable future	Less than 1% of total regional container traffic in 2002
Brunei	Muara (MCT)	Involvement and experience of PSA Corp	Lower volumes than Kuching, Bintulu, Kota Kinabalu and competing ports in Philippines (South)
		Known plans to increase capacity, yard, equipment	Vessel and transhipment stevedoring tariff costs more expensive than Bintulu and Kota Kinabalu

		Confirmed intentions to further invest in additional/improved handling equipment	Cross border trade weakened by levels of bureaucracy and "red-tape"
Brunei	**Muara (MCT)**	Better quality handling equipment than almost all regional competitors which is reflected in terminal productivity	Relatively low volume of base cargo
		Some base container traffic generated by regular customers on weekly schedules	
		Brunei GDP growth amongst SE Asia or of any developing country in the world - also has a high take-up of containers per head of population	
		Over 60% of weekly customer schedules are connections to major container facilities- ie Singapore, Hong Kong, Johor	
Indonesia	**Kalimantan/Sulawesi**	No spare capacity available, with current utilisation more than 100%	Very poor quality facilities at ports in Kalimantan
		Strong base container cargo for ports-large share of box traffic for region (18% in 2002, 25.9% in 2007)	Very low container volumes at ports in Kalimantan
		Hatta Quay at Makassar has good facilities-ship-to-shore cranes, sufficient water depth, yard etc	Majority of container handling limited to Makassar-hence higher utilisation
	Eastern Indonesia	Strong base cargo for ports-14% of total regional volumes in 2002,	Little spare spacity-utilisation over 80%
		Ports handle diverse cargo base, so not reliant upon one commodity (such as container traffic)	No known or confirmed plans to increase capacity
			Inability to offer designated container terminals-all boxes moved at multipurpose berths only

Philippines	**Mindanao/ Visayas**	Highest container volumes in 2002 of any BIMP-EAGA regional area	Traffic reliant upon strong domestic container demand
		Spare capacity available -current utilisation around 76%	Questionable whether additional capacity being constructed for Mindanao Container Terminal is required
		Has large share of regional container traffic (over 37%)	New terminal development is likely to draw container traffic from within Philippines terminals as opposed to competing facilities
		High propotion of container traffic is domestic cargo- unlikely (or unable) to move to other competing regional ports	Investment needed in newer, better handling equipment
		Increasing container capacity by 2005	Philippine Port Authority perceived as bureaucratic
		Involvement of ICTSI as terminal operator at SBCT in General Santos	Port tariffs reflect some high additional costs-ie an additional wharf charge of US$14.07 per box is levied
		Has established container facilities, offering Panamax cranes	Restrictions at some berths-ie domestic berths handle domestic tariff only

Source: Drewry Shipping Consultant Ltd, (2004) Muara Container Terminal market study and author's compilation from Brunei, Indonesia, Malaysia and the Philippines Port Authorities

Appendix I- BIMP-EAGA region's port throughput growth

			2002 TEU volume	2003 TEU volume	2004 TEU volume	2005 TEU volume	2006 TEU volume	2007 TEU volume	Avg. Growth
Region **East Malaysia**	**Port**	**Terminal Operator**	2002	2003	2004	2005	2006	2007	
Sarawak	Kuching	Kuching port authority	117,032	138999	141,227	143,096	152,394	163,338	7.08%
	Rajang	Rajang port authority	44,908	50,839	53,740	54,377	53,741	65,908	8.31%
	Bintulu	Bintulu Port Sdn. Bhd.	104,081	145,661	143,783	147,800	199,644	251,800	20.53%
	Miri	Miri port authority	7,422	13,300	14,402	14,739	16,644	21,296	26.14%
	Sarawak total					360,012	422,423	502,342	
Sabah	Kota Kinabalu	Sabah Port Sdn. Bhd.	113,846	-	-	147,800	156,386	183,608	11.61%
	Sandakan	Sabah Port Sdn. Bhd.	23,439	-	-	-	-	-	
	Tawau		33,628	-	-	-	72,698	87,402	20.23%
	Sabah total					147,800	229,084	271,010	
Federal Territory	Labuan		12,680	-	-	-	-	-	0.00%
Brunei	Muara	Muara, PSA MCT	67104	76,515	97,667	101,000	100,719	108,000	10.41%
	Brunei total					101,000	100,719	108,000	
Indonesia Kalimantan	Banjarmasin	PT (Persero) Pelabuhan Indonesia	-	-	-	-	-	-	

	Pontianak	PT (Persero) Pelabuhan Indonesia II	-	-	-	-	-	-	
	Samarinda	PT (Persero) Pelabuhan Indonesia IV	-	-	-	125,816	129,834	139,046	5.14%
	Balikpapan		-	-	-	68,168	66,069	78,163	7.61%
	Kalimantan total					193,984	195,903	217,209	
Sulawesi	Makassar	PT (Persero) Pelabuhan Indonesia IV	-	227,884	230,000	236,776	245,803	282,573	5.66%
	Pare-Pare		-	-	-	0	0	0	
	Bitung		-	-	-	101,051	98,926	113,847	6.49%
	Pantoloan		-	-	-	18,350	17,694	19,050	2.04%
	Sulawesi total		-	-	-	356,177	362,423	415,470	
Eastern Indonesia	Biak	PT (Persero) Pelabuhan Indonesia IV	-	-	-	4,204	4,334	5138	10.82%
	Ternate		-	-	-	10,176	14,077	16,052	26.18%
	Jayapura		-	-	-	22,792	27,786	35,744	25.28%
	Ambon		-	-	-	35,195	37,660	40,511	7.29%
	Sorong		-	-	-	11,197	16,766	15,682	21.64%
	Eastern Indonesia total					83,564	100,623	113127	
Philippines South Mindanao	Davao	Filipinas Port Services, Inc.Davao Integrated Port Services & Stevedoring Corp.	176,679	202,016	226,018	225,721	258,104	298,675	11.23%
	General Santos	South Cotabato Integrated Port Services, Inc.	116,807	115,256	120,548	110,108	97,323	103,577	-2.12%

	Pontianak	PT (Persero) Pelabuhan Indonesia II	-	-	-	-	-	-	
	Samarinda	PT (Persero) Pelabuhan Indonesia IV	-	-	-	125,816	129,834	139,046	5.14%
	Balikpapan		-	-	-	68,168	66,069	78,163	7.61%
	Kalimantan total					193,984	195,903	217,209	
Sulawesi	Makassar	PT (Persero) Pelabuhan Indonesia IV	-	227,884	230,000	236,776	245,803	282,573	5.66%
	Pare-Pare		-	-	-	0	0	0	
	Bitung		-	-	-	101,051	98,926	113,847	6.49%
	Pantoloan		-	-	-	18,350	17,694	19,050	2.04%
	Sulawesi total		-	-	-	356,177	362,423	415,470	
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	Ternate		-	-	-	10,176	14,077	16,052	26.18%
	Jayapura		-	-	-	22,792	27,786	35,744	25.28%
	Ambon		-	-	-	35,195	37,660	40,511	7.29%
	Sorong		-	-	-	11,197	16,766	15,682	21.64%
	Eastern Indonesia total					83,564	100,623	113127	
Philippines South Mindanao	Davao	Filipinas Port Services, Inc.Davao Integrated Port Services & Stevedoring Corp.	176,679	202,016	226,018	225,721	258,104	298,675	11.23%
	General Santos	South Cotabato Integrated Port Services, Inc.	116,807	115,256	120,548	110,108	97,323	103,577	-2.12%

	Ormoc	Ormoc Dockhandlers, Inc.	6,102	8,376	9,081	9,391	8,824	5,329	0.69%
	Tacloban	Leyte Integrated Port Services, Inc.	20,978	17,901	16,934	9,388	5,804	7,538	-14.59%
	Tagbilaran	Tagbilaran Maritime Services, Inc.	15,755	18,002	17,788	17,175	14,616	11,298	-5.59%
	Total BIMP-EAGA market		**1,298,351**	**1,487,459**	**1,588,036**	**2,097,386**	**2,231,035**	**2,449,679**	10.17%

Source: Author's own calculation derived from Brunei, Indonesia, Malaysia and Philippines Port Authority,

Note. Red character indicates data is unavailable

Labuan port- Federal Territory handled 12,680 TEU, Sandakan - 23,439 TEU, Banjarmasin-142,626 TEU, Pontianak-98,747 TEU in 2002

Appendix J- Total container market share in the BIMP-EAGA region

			2002 TEU volume	2002 % Market Share	2003 TEU volume	2003 % Market Share	2004 TEU volume	2004 % Market Share	2005 TEU volume	2005 % Market Share	2006 TEU volume	2006 % Market Share	2007 TEU volume	2007 % Market Share
Region East Malaysia	Port	Terminal Operator												
Sarawak	Kuching	Kuching port authority	117,032	9.0%	138,999	9.3%	141,227	8.9%	143,096	6.6%	152,394	6.8%	163,338	6.7%
	Rajang	Rajang port authority	44,908	3.5%	50,839	3.4%	53,740	3.4%	54,377	2.5%	53,741	2.4%	65,908	2.7%
	Bintulu	Bintulu Port Sdn. Bhd.	104,081	8.0%	145,661	9.8%	143,783	9.1%	147,800	6.8%	199,644	8.9%	251,800	10.3%
	Miri	Miri port authority	7,422	0.6%	13,300	0.9%	14,402	0.9%	14,739	0.7%	16,644	0.7%	21,296	0.9%
	Sarawak total		273,443		348,799		353,152		360,012		422,423		502,342	
Sabah	Kota Kinabalu	Sabah Port Sdn. Bhd.	113,846	8.8%					147,800	6.8%	156,386	7.0%	183,608	7.5%
	Sandakan	Sabah Port Sdn. Bhd.	23,439	1.8%					0	0.0%	0	0.0%	0	0.0%
	Tawau		33,628	2.6%							72,698	3.3%	87,402	3.6%
	Sabah total		170,913						208,458		229,084		271,010	
Federal Territory	Labuan		12,680	1.0%					0	0.0%	0	0.0%	0	0.0%
	Federal Territory total		12,680						0	0.0%	0	0.0%	0	0.0%
Brunei	Muara	Muara, PSA MCT	67,104	5.2%	76,515	5.1%	97,667	6.2%	101,000	4.7%	100,719	4.5%	108,000	4.4%
	Brunei total		67,104		76,515		97,667		101,000		100,719		108,000	
Indonesia Kalimantan	Banjarmasin	PT (Persero) Pelabuhan Indonesia IV							0	0.0%	0	0.0%	0	0.0%

	Pontianak	PT (Persero) Pelabuhan Indonesia II							0	0.0%	0	0.0%	0	0.0%
	Samarinda	PT (Persero) Pelabuhan Indonesia IV							129,834	6.0%	129,834	5.8%	139,046	5.7%
	Balikpapan								68,168	3.2%	66,069	3.0%	78,163	3.2%
	Kalimantan total								198,002		195,903		217209	
Sulawesi	Makassar	PT (Persero) Pelabuhan Indonesia IV			227,884	15.3%	230,000	14.5%	236,776	11.0%	245,803	11.0%	282,573	11.5%
	Pare-Pare								0	0.0%	0	0.0%	0	0.0%
	Bitung								101,051	4.7%	98,926	4.4%	113,847	4.6%
	Pantoloan								18,350	0.9%	17,694	0.8%	19,050	0.8%
	Sulawesi total				227,884		230,000		356,177		362,423		415,470	
Eastern Indonesia	Biak	PT (Persero) Pelabuhan Indonesia IV							4,204	0.2%	4,334	0.2%	5138	0.2%
	Ternate								10,176	0.5%	14,077	0.6%	16,052	0.7%
	Jayapura								22,792	1.1%	27,786	1.2%	35,744	1.5%
	Ambon								35,195	1.6%	37,660	1.7%	40,511	1.7%
	Sorong								11,197	0.5%	16,766	0.8%	15,682	0.6%
	Eastern Indonesia total								83,564		100,623		113127	
Philippines South Mindanao	Davao	Filipinas Port Services, Inc.Davao Integrated Port Services & Stevedoring Corp.	176,679	13.6%	202,016	13.6%	226,018	14.2%	225,721	10.5%	258,104	11.6%	298,675	12.2%
	General Santos	South Cotabato Integrated Port Services, Inc.	104,081	8.0%	115,256	7.7%	143,783	9.1%	110,108	5.1%	97,323	4.4%	103,577	4.2%

	Zamboanga	Unified Stevedoring & Arrastre Corp. Zamboanga Arrastre and Stevedoring Corp. PTC-Mindanao Port Services, Inc.	62,615	4.8%	69,884	4.7%	63,499	4.0%	64,093	3.0%	60,204	2.7%	63,675	2.6%
	South Mindanao total		343,375		387,156		433,300		399,922		415,631		465,927	
North Mindanao	Cagayan de Oro	Oroport	182,169	14.0%	194,929	13.1%	206,215	13.0%	202,236	9.4%	178,458	8.0%	161,992	6.6%
	Iligan	Iligan Merged Arrastre and Stevedoring Co.	24,473	1.9%	24,006	1.6%	27,636	1.7%	24,953	1.2%	24,499	1.1%	18,737	0.8%
	Nasipit	Nasipit Integrated Arrastre & Stevedoring Srvcs, Inc.	25,532	2.0%	28,456	1.9%	35,266	2.2%	41,776	1.9%	33,619	1.5%	27,436	1.1%
	Ozamiz	Integrated Port Services of Ozamiz	29,395	2.3%	28,567	1.9%	34,623	2.2%	31,046	1.4%	29,255	1.3%	28,826	1.2%
	Surigao	Bilang-Bilang Arrastre/Stevedoring Service, Inc.	5,624	0.4%	5,970	0.4%	6,192	0.4%	4,421	0.2%	4,140	0.2%	4,132	0.2%
	North Mindanao total		267,193		281,928		309,932		304,432		269,971		241,123	
Visayas	Dumaguete	Cipres Srevedoring and Arrastre, Inc.	22,971	1.8%	23,233	1.6%	22,470	1.4%	23,330	1.1%	20,529	0.9%	15,524	0.6%
	Iloilo	Iloilo Integrated Arrastre and Stevedoring Co. Visayan Veterans Port Services, Inc.	97,837	7.5%	97,665	6.6%	97,712	6.2%	87,193	4.0%	84,485	3.8%	75,782	3.1%

	Ormoc	Ormoc Dockhandlers, Inc.	6,102	0.5%	8,376	0.6%	9,081	0.6%	9,391	0.4%	8,824	0.4%	5,329	0.2%
	Tacloban	Leyte Integrated Port Services, Inc.	20,978	1.6%	17,901	1.2%	16,934	1.1%	9,388	0.4%	5,804	0.3%	7,538	0.3%
	Tagbilaran	Tagbilaran Maritime Services, Inc.	15,755	1.2%	18,002	1.2%	17,788	1.1%	17,175	0.8%	14,616	0.7%	11,298	0.5%
	Visayas total		163,643		165,177		163,985		146,477		134,258		115,471	
	Other									2.82%		-		-
	Total BIMP-EAGA market		1,298,351	100%	1,487,459	100%	1,588,036	100%	2,158,044	100%	2,231,035	100%	2,449,679	100%
			1,298,351	100%	1,487,459	100%	1,588,036	100%	2,097,386	97.19%	2,231,035	100%	2,449,679	100%

Source: Author's own calculation derived from Brunei, Indonesia, Malaysia and Philippines Port Authority,
Note. Red character indicates data is unavailable
Labuan port- Federal Territory handled 12,680 TEU, Sandakan - 23,439 TEU, Banjarmasin-142,626 TEU, Pontianak-98,747 TEU in 2002

Appendix K – Herfindahl Index (H) and Hirschman Index (HHI) 2002 to 2007

	Herfindhal Index (H) and Hefindahl Hirschman Index (HHI) 2002			H	HHI
1	Oroport	182,169	14.03%	0.0197	197
2 3	Filipinas Port Services, Inc.Davao Integrated Port Services & Stevedoring Corp.	176,679	13.61%	0.0185	185
4	Sabah Port Sdn. Bhd.	170,913	13.16%	0.0173	173
5	Kuching port authority	117,032	9.01%	0.0081	81
6	Bintulu Port Sdn. Bhd.	104,081	8.02%	0.0064	64
7	South Cotabato Integrated Port Services, Inc.Unified Stevedoring & Arrastre Corp.	104,081	8.02%	0.0064	64
8	Visayan Veterans Port Services, Inc.Iloilo Integrated Arrastre and Stevedoring Co.	97,837	7.54%	0.0057	57
9	PSA Muara Container Terminal	67,104	5.17%	0.0027	27
10 11	Zamboanga Arrastre and Stevedoring Corp.PTC-Mindanao Port Services, Inc.	62,615	4.82%	0.0023	23
12	Rajang port authority	44,908	3.46%	0.0012	12
13	Integrated Port Services of Ozamiz	29,395	2.26%	0.0005	5
14	Nasipit Integrated Arrastre & Stevedoring Srvcs, Inc	25,532	1.97%	0.0004	4
15	Iligan Merged Arrastre and Stevedoring Co.	24,473	1.88%	0.0004	4
16	Cipres Srevedoring and Arrastre, Inc.	22,971	1.77%	0.0003	3
17	Leyte Integrated Port Services, Inc.	20,978	1.62%	0.0003	3
18	Tagbilaran Maritime Services, Inc.	15,755	1.21%	0.0001	1
19	Labuan Port Sdn. Bhd.	12,680	0.98%	0.0001	1
20	Miri port authority	7,422	0.57%	0.0000	0
21	Ormoc Dockhandlers, Inc.	6,102	0.47%	0.0000	0
22	Bilang-Bilang Arrastre/Stevedoring Service, Inc.	5,624	0.43%	0.0000	0
23	Other ports	0	0	0.0000	0
	Total	1,298,351	100.00%	0.0905	905

Source: Author's own calculation derived from Brunei, Indonesia, Malaysia and Philippines Port Authority

	Herfindhal Index (H) and Hefindahl Hirschman Index (HHI) 2003			H	HHI
1	PT (Persero) Pelabuhan Indonesia IV	227,884	15.32%	0.0235	235
2 3	Filipinas Port Services, Inc.Davao Integrated Port Services & Stevedoring Corp.	202,016	13.58%	0.0184	184
4	Oroport	194,929	13.10%	0.0172	172
5	Bintulu Port Sdn. Bhd.	145,661	9.79%	0.0096	96
6	Kuching port authority	138,999	9.34%	0.0087	87
7	South Cotabato Integrated Port Services, Inc.Unified Stevedoring & Arrastre Corp.	115,256	7.75%	0.0060	60
8 9	Visayan Veterans Port Services, Inc.Iloilo Integrated Arrastre and Stevedoring Co.	97,665	6.57%	0.0043	43
10	PSA Muara Container Terminal	76,515	5.14%	0.0026	d
11 12	Zamboanga Arrastre and Stevedoring Corp.PTC-Mindanao Port Services, Inc.	69,884	4.70%	0.0022	22
13	Rajang port authority	50,839	3.42%	0.0012	12
14	Cipres Srevedoring and Arrastre, Inc.	23,233	1.56%	0.0002	2
15	Integrated Port Services of Ozamiz	28,567	1.92%	0.0004	4
16	Iligan Merged Arrastre and Stevedoring Co.	28,456	1.91%	0.0004	4
17	Iligan Merged Arrastre and Stevedoring Co.	24,006	1.61%	0.0003	3
18	Tagbilaran Maritime Services, Inc.	18,002	1.21%	0.0001	1
19	Leyte Integrated Port Services, Inc.	17,901	1.20%	0.0001	1
20	Miri port authority	13,300	0.89%	0.0001	1
21	Ormoc Dockhandlers, Inc.	8,376	0.56%	0.0000	0
22	Bilang-Bilang Arrastre/Stevedoring Service, Inc.	5,970	0.40%	0.0000	0
	Other ports	0	0.00%	0.0000	0
	Total	1,487,459	100.00%	0.0954	928

Source: Author's own calculation derived from Brunei, Indonesia, Malaysia and Philippines Port Authority

	Herfindhal Index (H) and Hefindahl Hirschman Index (HHI) 2004			H	HHI
1	PT (Persero) Pelabuhan Indonesia IV	230,000	14.48%	0.0210	4
2	Filipinas Port Services, Inc.Davao Integrated Port	226,018	14.23%	0.0203	4
3	Oroport	206,215	12.99%	0.0169	3
4	Bintulu Port Sdn. Bhd.	143,783	9.05%	0.0082	1
5	Kuching port authority	141,227	8.89%	0.0079	1
6 7	South Cotabato Integrated Port Services, Inc.Unified Stevedoring & Arrastre Corp.	120,548	7.59%	0.0058	0
	PSA Muara Container Terminal	97,667	6.15%	0.0038	0
8 9	Visayan Veterans Port Services, Inc.Iloilo Integrated Arrastre and Stevedoring Co.	97,712	6.15%	0.0038	0
10 11	Zamboanga Arrastre and Stevedoring Corp.PTC-Mindanao Port Services, Inc.	63,499	4.00%	0.0016	0
12	Rajang port authority	53,740	3.38%	0.0011	0
13	Nasipit Integrated Arrastre & Stevedoring Srvcs, Inc.	35,266	2.22%	0.0005	0
14	Integrated Port Services of Ozamiz	34,623	2.18%	0.0005	0
15	Iligan Merged Arrastre and Stevedoring Co.	27,636	1.74%	0.0003	0
16	Cipres Srevedoring and Arrastre, Inc.	22,470	1.41%	0.0002	0
17	Tagbilaran Maritime Services, Inc.	17,788	1.12%	0.0001	0
18	Leyte Integrated Port Services, Inc.	16,934	1.07%	0.0001	0
19	Miri port authority	14,402	0.91%	0.0001	0
20	Ormoc Dockhandlers, Inc.	9,081	0.57%	0.0000	0
21	Bilang-Bilang Arrastre/Stevedoring Service, Inc.	6,192	0.39%	0.0000	0
22	1	5,809	0.37%	0.0000	0
23	2	5,809	0.37%	0.0000	0
24	3	5,809	0.37%	0.0000	0
25	4	5,809	0.37%	0.0000	0
	Total	1,588,036	100.00%	0.0922	13

Source: Author's own calculation derived from Brunei, Indonesia, Malaysia and Philippines Port Authority

	Herfindhal Index (H) and Hefindahl Hirschman Index (HHI) 2005			H	HHI
1	PT (Persero) Pelabuhan Indonesia IV	633,725	30.21%	0.0913	913
2 3	Filipinas Port Services, Inc.Davao Integrated Port Services & Stevedoring Corp.	225,721	10.76%	0.0116	116
4	Oroport	202,236	9.64%	0.0093	93
5	Bintulu Port Sdn. Bhd.	147,800	7.05%	0.0050	50
6	Sabah Port Sdn. Bhd.	147,800	7.05%	0.0050	50
7 8	South Cotabato Integrated Port Services, Inc.Unified Stevedoring & Arrastre Corp.	110,108	5.25%	0.0028	28
9	Kuching port authority	143,096	6.82%	0.0047	47
	PSA Muara Container Terminal	101,000	4.82%	0.0023	23
8 9	Visayan Veterans Port Services, Inc.Iloilo Integrated Arrastre and Stevedoring Co.	87,193	4.16%	0.0017	17
10 11	Zamboanga Arrastre and Stevedoring Corp.PTC-Mindanao Port Services, Inc.	64,093	3.06%	0.0009	9
12	Rajang port authority	54,377	2.59%	0.0007	7
13	Nasipit Integrated Arrastre & Stevedoring Srvcs, In	41,776	1.99%	0.0004	4
14	Integrated Port Services of Ozamiz	31,046	1.48%	0.0002	2
15	Iligan Merged Arrastre and Stevedoring Co.	24,953	1.19%	0.0001	1
16	Cipres Srevedoring and Arrastre, Inc.	23,330	1.11%	0.0001	1
17	Tagbilaran Maritime Services, Inc.	17,175	0.82%	0.0001	1
18	Miri port authority	14,739	0.70%	0.0000	0
19	Leyte Integrated Port Services, Inc.	9,388	0.45%	0.0000	0
20	Ormoc Dockhandlers, Inc.	9,391	0.45%	0.0000	0
21	Bilang-Bilang Arrastre/Stevedoring Service, Inc.	4,421	0.21%	0.0000	0
22	1	4,018	0.19%	0.0000	0
	Total	2,097,386	100.00%	0.1362	1362

Source: Author’s own calculation derived from Brunei, Indonesia, Malaysia and Philippines Port Authority

	Herfindhal Index (H) and Hefindahl Hirschman Index (HHI) 2006			H	HHI
1	PT (Persero) Pelabuhan Indonesia IV	658,949	29.54%	0.0872	76
2 3	Filipinas Port Services, Inc.Davao Integrated Port Services & Stevedoring Corp.	258,104	11.57%	0.0134	2
4	Sabah Port Sdn. Bhd.	229,084	10.27%	0.0105	1
5	Bintulu Port Sdn. Bhd.	199,644	8.95%	0.0080	1
6	Oroport	178,458	8.00%	0.0064	0
7	Kuching port authority	152,394	6.83%	0.0047	0
8	PSA Muara Container Terminal	100,719	4.51%	0.0020	0
9	South Cotabato Integrated Port Services, Inc.Unified Stevedoring & Arrastre Corp.	97,323	4.36%	0.0019	0
10 11	Visayan Veterans Port Services, Inc.Iloilo Integrated Arrastre and Stevedoring Co.	84,485	3.79%	0.0014	0
12 13	Zamboanga Arrastre and Stevedoring Corp.PTC-Mindanao Port Services, Inc.	60,204	2.70%	0.0007	0
14	Rajang port authority	53,741	2.41%	0.0006	0
15	Nasipit Integrated Arrastre & Stevedoring Srvcs, Inc.	33,619	1.51%	0.0002	0
16	Integrated Port Services of Ozamiz	29,255	1.31%	0.0002	0
17	Iligan Merged Arrastre and Stevedoring Co.	24,499	1.10%	0.0001	0
18	Cipres Srevedoring and Arrastre, Inc.	20,529	0.92%	0.0001	0
19	Miri port authority	16,644	0.75%	0.0001	0
20	Tagbilaran Maritime Services, Inc.	14,616	0.66%	0.0000	0
21	Ormoc Dockhandlers, Inc.	8,824	0.40%	0.0000	0
22	Leyte Integrated Port Services, Inc.	5,804	0.26%	0.0000	0
23	Bilang-Bilang Arrastre/Stevedoring Service, Inc.	4,140	0.19%	0.0000	0
	Other ports	0	0.00%	0.0000	0
	Total	2,231,035	100.00%	0.1376	80

Source: Author's own calculation derived from Brunei, Indonesia, Malaysia and Philippines Port Authority

	Herfindhal Index (H) and Hefindahl Hirschman Index (HHI) 2007			H	HHI
1	PT (Persero) Pelabuhan Indonesia IV	745806	30.45%	0.0927	927
2 3	Filipinas Port Services, Inc.Davao Integrated Port Services & Stevedoring Corp.	298675	12.19%	0.0149	149
4	Sabah Port Sdn. Bhd.	271010	11.06%	0.0122	122
5	Bintulu Port Sdn. Bhd.	251800	10.28%	0.0106	106
6	Kuching port authority	163338	6.67%	0.0044	44
7	Oroport	161992	6.61%	0.0044	44
8	PSA Muara Container Terminal	108000	4.41%	0.0019	19
9	South Cotabato Integrated Port Services, Inc.Unified Stevedoring & Arrastre Corp.	103577	4.23%	0.0018	18
10 11	Visayan Veterans Port Services, Inc.Iloilo Integrated Arrastre and Stevedoring Co.	75782	3.09%	0.0010	10
12	Rajang port authority	65908	2.69%	0.0007	7
13 14	Zamboanga Arrastre and Stevedoring Corp.PTC-Mindanao Port Services, Inc.	63675	2.60%	0.0007	7
15	Integrated Port Services of Ozamiz	28826	1.18%	0.0001	1
16	Nasipit Integrated Arrastre & Stevedoring Srvcs, Inc.	27436	1.12%	0.0001	1
17	Miri port authority	21296	0.87%	0.0001	1
18	Iligan Merged Arrastre and Stevedoring Co.	18737	0.76%	0.0001	1
19	Cipres Srevedoring and Arrastre, Inc.	15524	0.63%	0.0000	0
20	Tagbilaran Maritime Services, Inc.	11298	0.46%	0.0000	0
21	Leyte Integrated Port Services, Inc.	7538	0.31%	0.0000	0
22	Ormoc Dockhandlers, Inc.	5329	0.22%	0.0000	0
23	Bilang-Bilang Arrastre/Stevedoring Service, Inc.	4132	0.17%	0.0000	0
	Other ports	0	0.00%	0.0000	0
	Total	2,449,679	100.00%	0.1457	1457

Source: Author's own calculation derived from Brunei, Indonesia, Malaysia and Philippines Port Authority

Appendix L – DEA result

Table: 29 - Input and output target

	Efficient Input Target			Efficient Output Target
DMU Name	**Yard area (ha)**	**No of gantry cranes**	**Quay length (m)**	**Terminal throughput (2007) TEU**
Kuching	2.89844	0.00000	503.12534	163338.0
Bintulu	7.00000	2.00000	480.00000	251800.0
Kota Kinabalu	1.48363	0.00000	257.53531	83608.0
Muara MCT	3.92237	1.30098	196.11830	108000.0
Makassar	11.50000	4.00000	500.00000	282573.0
Bitung	1.85769	0.00000	527.58304	113847.0
Ambon	0.71887	0.00000	124.78487	40511.0
Davao	5.30000	0.00000	920.00000	298675.0
General Santos	1.73737	0.00000	428.55079	103577.0
Zamboanga	1.12992	0.00000	196.13627	63675.0
Cagayan de Oro	3.35977	0.38330	442.32554	161992.0
Iloilo	1.34475	0.00000	233.42911	75782.0
Samarinda	2.00000	0.00000	937.00000	139046.0
Balikpapan	1.12428	0.00000	526.72303	78163.0

Source: Author's own calculation derived from various source

Table: 30 - Result of DEA-CRS

DMU Name	Efficency CRS	Optimal Lambdas with Benchmarks	
Kuching	0.40315	0.547	Davao
Bintulu	1.00000	1.000	Bintulu
Kota Kinabalu	0.37378	0.280	Davao
Muara MCT	0.78447	0.398	Bintulu
Makassar	1.00000	1.000	Makassar
Bitung	0.37154	0.567	Davao
Ambon	0.27730	0.136	Davao
Davao	1.00000	1.000	Davao
General Santos	0.57912	0.462	Davao
Zamboanga	0.61293	0.213	Davao
Cagayan de Oro	0.38330	0.572	Bintulu
Iloilo	0.45503	0.254	Davao
Samarinda	1.00000	1.000	Samarinda
Balikpapan	0.80305	0.562	Samarinda

Source: Author's own calculation derived from various source

Table: 31 - VRS, CRS and Scale efficiency

DMU Name	Input-Oriented VRS Efficiency	Efficency CRS	Scale efficency CRS/VRS
Kuching	0.46030	0.40315	0.8758
Bintulu	1.00000	1.00000	1.0000
Kota Kinabalu	0.61349	0.37378	0.6093
Muara MCT	1.00000	0.78447	0.7845
Makassar	1.00000	1.00000	1.0000
Bitung	0.45599	0.37154	0.8148
Ambon	0.71111	0.27730	0.3900
Davao	1.00000	1.00000	1.0000
General Santos	0.77594	0.57912	0.7464
Zamboanga	1.00000	0.61293	0.6129
Cagayan de Oro	0.43452	0.38330	0.8821
Iloilo	0.68404	0.45503	0.6652
Samarinda	1.00000	1.00000	1.0000
Balikpapan	1.00000	0.80305	0.8031

Source: Author's own calculation derived from various source

Table: 32 - Slack input factors

Input Slacks			
DMU Name	**Yard area (ha)**	**No of gantry cranes**	**Quay length (m)**
Kuching	10.40536	0.00000	0.00000
Bintulu	0.00000	0.00000	0.00000
Kota Kinabalu	0.01150	0.00000	0.00000
Muara MCT	0.00000	0.26796	0.00000
Makassar	0.00000	0.00000	0.00000
Bitung	0.00000	0.37154	0.00000
Ambon	2.05413	0.00000	0.00000
Davao	0.00000	0.00000	0.00000
General Santos	0.00000	1.15825	0.00000
Zamboanga	0.34111	0.00000	0.00000
Cagayan de Oro	0.66485	0.00000	0.00000
Iloilo	0.79387	0.00000	0.00000
Samarinda	0.00000	0.00000	0.00000
Balikpapan	0.00000	0.00000	15.33833

Source: Author's own calculation derived from various source

Appendix M - Comparison of port transhipment tariff

	Muara (MCT)		Bintulu		Kota Kinabalu	
	B$	US$	B$	US$	B$	US$
20ft loaded	100	57.45	22.5	12.93	85	48.83
20ft empty	65	37.34	12.5	7.18	85	48.83
40ft loaded	150	86.18	28.75	16.52	127.5	73.25
40ft empty	89	51.13	25	14.36	127.5	73.25
Average per teu-per move**	71.77	41.23	15.23	8.75	69.07	39.68
Average per teu-per cycle**	143.54	82.46	30.46	17.5	138.12	79.35
Average per container per move**	114.81	65.96	24.37	14	110.5	63.48
Average per container complete cycle**	229.64	131.93	48.76	28.01	220.99	126.96

Source: Drewry Shipping Consultants Ltd (2004) Muara terminal market study

Notes:B$=US$0.5745 (US$=$B1.74) ** Assuming 1.6 teu per move and 30% empties

Appendix N - Utilisation of sub-regions in BIMP-EAGA region, 2005,2006,2007

Region	2005			2006			2007		
	Throughput	Capacity	% utilisation	Throughput	Capacity	% utilisation	Throughput	Capacity	% utilisation
Sarawak	360,012	575,000	62.6%	422,423	575,000	73.5%	502,342	575,000	87.4%
Sabah	147,800	285,000	51.9%	229,084	285,000	80.4%	271,010	285,000	95.1%
Federal Territory	0	25,000	0.0%	0	25,000	0.0%	0	25,000	0.0%
Muara	101,000	250,000	40.4%	100,719	250,000	40.3%	108,000	250,000	43.2%
Kalimantan/ Sulawesi	554,179	615,000	90.1%	558,326	615,000	90.8%	632,679	615,000	102.9%
Eastern Indonesia	83,564	300,000	27.9%	100,623	300,000	33.5%	113,127	300,000	37.7%
Mindanao	704,354	780,150	90.3%	685,602	780,150	87.9%	707,050	780,150	90.6%
Visayas	146,477	500,000	29.3%	134,258	500,000	26.9%	115,471	500,000	23.1%
Total	2,097,386	3,330,150	63.0%	2,231,035	3,330,150	67.0%	2,449,679	3,330,150	73.6%

Source: Author's own calculation and compilation from Brunei, Indonesia, Malaysia and Philippines Port Authority

Note: No data is available for Labuan port- Federal Territory handled 12,680 TEU in 2002

Appendix O - Port infrastructure in the BIMP-EAGA region

Region	Port	Berth name/number	Length (m)	Depth (m)	Yard (ha)	No. of cranes/cargo handling method	Berth use/cargo handled	Notes
East Malaysia								
Sarawak	Kuching	Pending Terminal	1248	8.5-11	33	Ships gear	Containers	Also has oil jetties
		Sejingkat Terminal	125	9	1	Ships gear	Containers/general cargo	
	Rajang	Sibu	448	8.5	8	Ships gear	Containers/general cargo	General cargo capacity of 450,000m3. Bulk oil facility at Sungai Merah
		Sarikei	146	7.6	1	Ships gear	Containers/general cargo	General cargo capacity of 104,000m3
		Tanjung Manis	203	10	5	Ships gear	Containers/general cargo	General cargo capacity of 200,000m3
	Bintulu	Container Terminal	480	10.5-13.5	7	2 gantry crane	Containers/general cargo	Expansion plans
	Miri	General cargo berth	254	2.1		Ships gear	Containers/general cargo	Container terminal built?
Sabah	Kota Kinabalu	South Jetty	689	5.8-9.5	4	Ships gear	Containers	
		Berths 1-7	1285	5.8-9.6	25	Ships gear	Containers/general cargo	Shore cranes only but move 6-18 teu per hour
	Sandakan	SPA Wharf	576	11	3	Ships gear	Containers	Further 507m general cargo berth
	Tawau	Berths 1 &2	655	06-Sep	12	Ships gear	Containers/general cargo	Also has oil jetties

Federal Territory	Labuan	New Liberty/Victoria wharves	328	7.6-8.2	2	Ships gear	Containers/general cargo	Also a bulk/passenger port
Indonesia Kalimantan	Pontianak	Berths 1-3	527	2.5-5	5	2 gantry crane, 2 reach stackers, 3 top loaders, 3 side loader,11 chasis,7 head truck	Containers/general cargo	Wooden jetties
	Samarinda	Two wooden wharves in very poor condition, with 2 x 12t mobile cranes. Not sufficient for container activity	937	5.5	2	2 shore crane, 3 forklift	Containers/general cargo	
	Balikpapan	11 berths-all tanker/dry bulks, no container activity	675	12	1.4	2 shore crane, 3 forklift, 2 truck loader		
	Banjarmasin	Trisakti wharf	200	8.0-10.0	7	Ships gear	Negligible container activity	
Sulawesi	Makassar	Hatta Quay	850	11	12	4 gantry crane,14 head truck,32 chasis,8 transtainer,2 reach stacker,2 top loader	Container	General/bulk wharves, 5mhcs,800m quay
	Pare-Pare	Two wharves	145	8.0-15.0	10	Ships gear	Predominantly livestock	Export livestock and cruise traffic only
	Bitung	Pier nos: 0-150, 150-382, 392-582	1,420	7	5	1 gantry crane, 2 transtainer, 3 head truck, 2 reach stacker, 3 chasis	General cargo	No dedicated container wharf, although has been considered

Eastern Indonesia	Pantoloan	Cargo berth	75	8.4	0	1 x 15t	General cargo	No container-no landside facilities
	Biak	Cargo berth	142	12	0	1 x mhc	General cargo	No container-no landside facilities
	Ternate	Yani Wharf	248	7.6	1	1 x mhc	General cargo	General/bulk wharves
	Jayapura	Wharf 1 & 2	248	5.8-8.8	5	1 x 25t mhc	General cargo	Port condition, no container capability
	Ambon	Yos (Jos) Sudaraso Quay	450	7.5-12.7	10	Mhc's to 40t	Containers/general cargo	Also oil wharf.Max cargo vessel 187m, 12m draft
	Sorong	General cargo berth	280	9.0-11.0	3	Ships gear	General cargo	Oil wharf. Passenger ships via cargo wharf also
South Philippines South Mindanao	Davao	9 multi purpose berth	920	10.6	5.3 ha	3xmch's/ships gear Ro-Ro	Containers/general cargo	
North Mindanao	General santos	Makar wharf	740	10.5-12.0	3 ha.	2 panamax/1x mhc Ships gear/Ro-Ro	Container/general cargo	SBCT main container centre (ICTSI)
	Zamboanga	Multi purpose berth	320	10	2.4	Ships gear/Ro-Ro	Container/general cargo	
	Cagayan De Oro	Macabalan wharf phases I/II (6 berths)	1,154m	8.5-11	10.5	1xgantry/mhc Ships gear/Ro-Ro	Container/general cargo	Mindanao container terminal project, roro/tankers/passenger also
	Iligan	Multi purpose berth	520	5.4	8,623 sq.m.	Ships gear/Ro-Ro	Containers/general cargo	bulks
	Nasipit	Container berth	184	7	1	Ships gear/Ro-Ro	Containers/general cargo	
	Ozamiz	Multi purpose berth	633	6.0-7.0	1.6 ha.	Ships gear/Ro-Ro	Containers/general cargo	
	Surigao	Berth 1-4	529	8	1.5 ha.	Ships gear	Containers/general cargo	Predominately port for luxury pleasure craft

Visayas	Dumaguete	Pier 1 & 2	166m x 30m 79m x 16m	5.0-8.0	1,945 sq.m.	Ships gear/Ro-Ro	Containers/general cargo	
	Iloilo	Multi purpose berth	513 Domestic 400 Foreign	6-10.5	1.7 ha. 2.7 ha.	Ships gear/Ro-Ro	Containers/general cargo	
	Ormoc	Multi purpose berth	218 m. Pier	4.0-5.0	2,709 sq.m.	Ships gear/Ro-Ro	Containers/general cargo	
	Tacloban	Multi purpose berth	622	4.0-6.0	6,939 sq.m.	Ships gear	Containers/general cargo	
	Tagbilaran	5 multi purpose berth	265	6.0-9.0	3.3 ha	Ships gear/Ro-Ro	Containers/general cargo	
Brunei	Muara	Muara Container Terminal	250 m	12.5 m	5 ha	2 panamax gantry crane	Containers	Container terminal capacity of 220,000 TEU

Source: Drewry Shipping Consultant Ltd, (2004) – Muara container terminal market study and author's compilation from Brunei, Indonesia, Malaysia and Philippines Port Authority

Appendix P – Shipping patterns in Brunei, Sabah and Sarawak intra Asian trades

Port of call pattern	Total Services per week*	Of which calling at: Bintulu	Sandakan	Kuching	Tawau
		North East and East Asia			
Singapore	26.2				
Port Klang	16				
Pasir Gudang	7.0				
Jakarta	11.8				
Surabaya	5.8				
Semarang	1.8				
HCMC	10.0				
PTP	2.0				
Bangkok/Laem Chabang	18.5		0.25	0.25	0.25
Manila	14.0				
None of the above	1.25				
Total services	56.0		0.25	0.25	0.25
		East Asia only			
Singapore	8	1			
Port Klang	9	1			
Pasir Gudang	2	1			
Jakarta	5				
Surabaya	3				
		East Asia only			
Singapore	8	1			
Port Klang	9				
Pasir Gudang	2				
Jakarta	5				
Surabaya	3				
Semarang	1				

HCMC(Ho Chi Min City)	7		
PTP(Tanjung Pelepas)	0		
Bangkok/Laem Chabang	7		
Manila	12	1	
None of the above	2.7	0.7	
Total services	29.7	1	

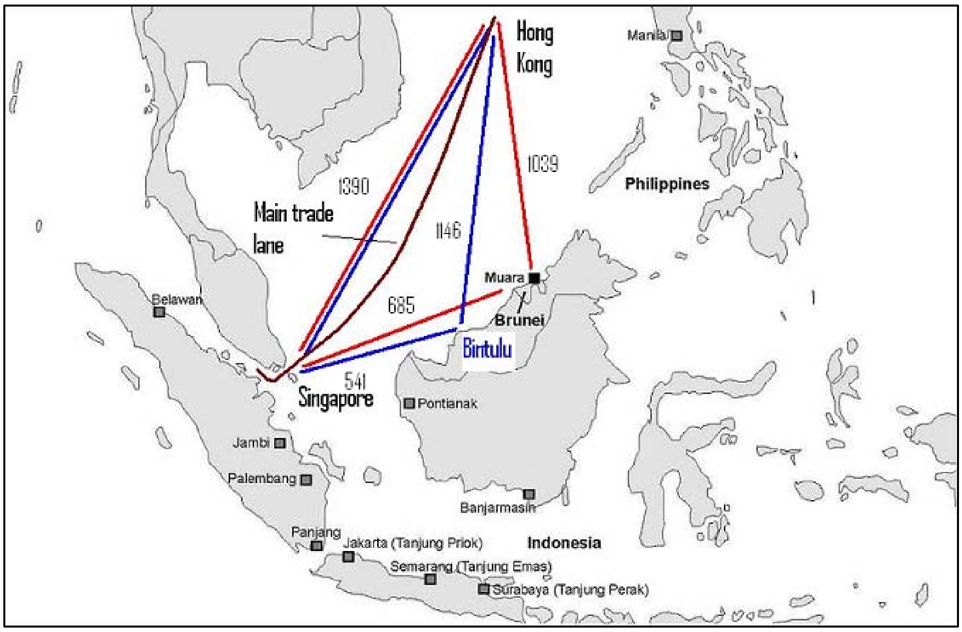
Source: Drewry Shipping Consultants, (2004) Muara Container Terminal market study

*Excludes pure feeder services

Appendix Q - Deviation distance of selected port from the main trade lane Hong Kong to Singapore route

NO	Singapore strait	To the port (nm)	Hong Kong	Deviation distance (nm)
	Port		1390	
1	**Muara MCT**	685	1039	334
2	**Singapore**	27	1417	54
3	**Bintulu**	541	1146	297
4	**Kuching**	390	1261	261
5	**Kota Kinabalu**	757	987	354
6	**Makassar**	1004	1712	1326
7	**Bitung**	1444	1418	886
8	**Ambon**	1562	1786	1372
9	**Davao**	1442	1309	775
10	**General Santos**	1340	1240	604
11	**Zamboanga**	1140	1034	198
12	**Cagayan de Oro**	1308	1051	383
13	**Samarinda**	987	1500	511
14	**Balikpapan**	956	1536	516

Source: Author's own calculation, distance sourced from Lloyd's Register-Fairplay, (2008). Distance tables. Fairplay world shipping Encyclopedia [electronic source]. Coulsdon, Survey, UK: author.



Source: Author's own source and compilation