A COMPUTER SIMULATION MODELLING STUDY FOR PORT PLANNING OF MAIN PUBLIC TERMINAL, PORT OF PALEMBANG, SOUTH SUMATERA, INDONESIA.

By: Budiyono
Delft/Nijmegen, June 1988

International Institute for Hydraulic and
Environmental Engineering, Delft, The Netherlands

A thesis submitted for awarding the degree of Master of Science of the International Institute for Hydraulic and Environmental Engineering, Delft, The Netherlands.

Supervisors:

Prof. ir. H. Velsink
ir. J.H.C. Wiersma
ir. R. Moor
ir. N.W. van den Hazel
ir. R. Groenveld

Examination Committee:

Prof. ir. H. Velsink
Prof. ir. W.F.T. van Ellen
ir. J.H.C. Wiersma
ir. R. Moor
ir. N.W. van den Hazel
ir. R. Groenveld

This study was undertaken for educational purposes only.

Although it is based on an existing situation and on realistic data, the conclusions of the study do not necessarily correspond with the ideas and conclusions of the individual members of the MSc.-committee nor of their respective employers.

To all those who have supported me when I most needed encouragement or help: my dearest Duti, my family, colleagues, superiors, and college advisors.

Acknowledgements

I wish to express my thanks to:

International Institute for Hydraulic and Environmental Engineering (IHE), Delft:
- Prof. ir. W.A. Segeren
- Prof. ir. W.F.T. van Ellen
- ir. J.H.C. Wiersma
- Dr. ir. P.J.M. de Laat
- ir. J.H. Koster

Delft University of Technology, Delft:
- Prof. ir. H. Velsink
- ir. R. Groenveld

Haskoning, Royal Dutch Consulting Engineering, Nijmegen:
- ir. N.W. van den Hazel
- ir. R. Moor
- ing. Topper
- ing. R. van der Laan
- ir. Willems

Directorate General of Sea Communication, Jakarta:
- ir. Sadhu Adisasmita Dipl. HE

Public Port Corporation II, Jakarta:
- ir. R.J. Lino Dipl. HE

SUMMARY

1. The present study on the application of personal computer simulation modelling for port planning of Main Public Terminal, port of Palembang, Indonesia, was carried out as a part of the requirement to obtain M.Sc degree of IHE, Delft, the Netherlands.

2. The main problem which will be solved in this study is that concerning the Main Public Terminal (MPT) capacity : berthing, cargo handling and cargo storage capacity within the time span of development plan,up to 2005. The objective of the development plan is then defined, i.e. to provide MPT the least-cost of port operation consisting of port investment, ship operational cost in port, and cargo handling cost. Thus the relevant criterion to be used is the optimization of berth length, storage facilities and other major fixed investment. In order to find the proper solution for the above problem, the strategy of the development plan is that the less-cost potential solution should be first investigated. Thus first investigation is concerning the operational improvement measures : the longer working time and the more effective cargo handling operation. These measures are covered in the Port Improvement Action Plan being implemented at present. Only if these measures cannot solve the above problem, the expansion of existing MPT or even the construction of new terminal will be considered.

3. The investigation of the future MPT capacity obviously necessitates the analysis of the future MPT demand : cargo flow and ship traffic. Based on the present maritime policy and location and function of MPT,several assumtions were made : limited shuttle service Tanjungpriok-Palembang, continuity of present shipping Singapure-Palembang and LASH service , little diversion to new deep-sea port of Bengkulu and ferry port of Bakahuni, gradual shift from midstream operation to MPT, and medium level of containerization. Together with asumptions made for each commodity, the resulting traffic forecast at the MPT is :

	1986	1990	1995	2005
Cargo flow (000 t)				
International	88.5	132.5	222.0	437.0
Domestic	218.5	267.5	345.0	722.0
(Total)	(307.0)	(400.0)	(567.0)	(1159.0)
of int. in TEU	2140	4500	8000	19000
% containerization	16	23	35	49
Annual shipcalls	875	1083	1406	2662

4. For a complex system such as MPT system, the simulation becomes a more appropiate tool to investigate berthing capacity than the queueing theory. Moreover, this technique offers informations needed for cargo handling and storage analysis. The availability of the Personal Prosim software provided by Haskoning led to the use of Prosim simulation language for this study. One main feature of this software is that it is destined for use on personal computer. The following brief explanation concerning various aspects in the simulation modelling of MPT :
   a. Desired outputs were determined mainly based on the identified problem and specified purpose of this study. They can be grouped into : time related, cost related, and miscellaneous operation outputs.
   b. Data gathering aims at : for inputs (terminal facilities, operational parameters, ship and cargo), for validation (1986 berth utilization)
   c. Model building includes : schematization,verbal model (or configuration, structure and process description) and coding/programming.
   d. Verification
   e. Validation : the actual data reside within the interval of 95 % confidence level of model generated data.
   f. Experimental design for determining simulation time.The regenerative method was proven not applicable. The repeated runs method was considered not practical. Using the one run for several subruns method gave statistically acceptable simulation time of 3½ years, consisting of initialization phase To of 3 months and gathering data phase Te of 3 1/4 years (13 subruns of 3 months). However, by considering the IBM PC-AT computing time not to exceed 2 hours for practical reason, Te of 2 , 1 and ½ years were taken for 1986 & 1990, 1995, and 2005 experimentation runs respectively.
   g. Experimentation runs were arranged based on the strategy of the development plan.
   h. Documentation and interpretation of outputs.

5. The 1986 existing and future requirement of berthing and storage facilitites, for International Subterminal (IS) and Domestic Subterminal (DS) :

	1986		1990		1995		2005	
	IS	DS	IS	DS	IS	DS	IS	DS
a. Quay (m)	360	375	360	375	360	400	510	400
b. Shed (000 m2)								
- NCC	8.8		2.4	2.7	2.6	3.1	4.3	4.2
- CFS	-		-	-	-	-	6.0	-
c. Yard (000 m2)								
- NCC	8.2		4.8	2.2	7.0	2.5	13.0	4.0
- CY	10.0		10.7	-	18.0	-	21.0	-

1988 : 18.0

Thus major expansion of storage facilities of IC and some modifications will have to be incorporated in the preparation of the 2005 MPT masterplan layout.

The additional of quay length was not because of berthing capacity reasons, but for better cargo handling operation.

6. With regard to development plan, the following conclusions and recommendations were made :
   a. It is suggested that the full-scale of the multi-shift working system be implemented as soon possible However, if that suggestion cannot be carried out immediately, the gradual improvement is recommended. In this case, the two-shift working system will have to be achieved by 2005
   b. As far as the above operation improvement are taken at proper time, the extention of quay, either international or domestic, will not be required until 2005. Furthermore, simulated 2005 situation indicated that for development after 2005, the domestic quay will likely have to be extended first before any attempt to build a new international quay.
   c. There will be no expansion of domestic non-container cargo (NCC) storage facilities. For storage facilities of either international NCC or container , some modifications are needed by 1995 and major expansion has to be executed by 2005.
   c. A large-scale replacement of cargo handling equipments should be carried out partly by 1995 and partly by 2005.

7. With regard to the utilization of computer simulation modelling, it turned out that this technique offers various outputs which cannot be obtained by applying other technique, such as : detailed composition of time spent by ship in port, results of varying planning interventions (quay length, number of quay crane, operational factors), and information regarding daily amount of cargo in storage facilities. However, this effective technique should be carefully applied, especially if it is assisted by present-day personal computer. There is still a strict trade-off between a great detailed outputs on the one hand and computing time consideration and capacity limitation of the personal computer on the other hand.

Table of contents

chapter I
INTRODUCTION

chapter I
INTRODUCTION

1.1 General Description

Palembang which is the capital city of the province of South Sumatra, has been a commercial centre of this region since the Sumatran maritime kingdom of Srivijaya rose in the 7th century AD and controlled much of the trade of South East Asia by ruling the strait of Malaka between Sumatra and Malay peninsula. Figure 1.1 shows the Palembang position in this region.

The port of Palembang is situated approximately 100 kms up the Musi river from the deep sea (see figure 1.2). A number of shoals in the river and a bar (shallow part) at the entrance restrict the navigatibility of this river. Being a tidal river, it is also dependent on the incoming and outgoing tide, where the tidal differences at the bar and at Palembang are about 3.10 m and 2.40 m respectively. Nevertheles there is fairly extensive development along both river banks near to the Palembang city, where various waterfront industrial areas are provided with loading/discharging facilities.

Loading/discharging of cargo at the port of Palembang is partly carried out via the public terminal, partly via the private terminals, and partly in midstream river (see figure 1.3). The public terminal, which is owned and operated by state company Public Port Corporation II (Perumpel II), branch Palembang, consist of: the main public terminal (MPT) at Boom Baru, sailing vessel terminal (SVT) at Sungai Lais, and mid-river dolphins (mooring facilities) at the front of the MPT. Whereas the privately owned terminals include: oil jetties at Plaju and Sungai Gerong operated by Pertamina, a ferlizer jetty in use by PT Pusrilocated opposite Plaju, a coal wharf at Kertapati operated by PT Taba, a salt jetty at Palembang used by PN Garam, and other wharves along both river banks where loading/discharging of cargo is handled by private companies. Meanwhile, the midstream operation takes place in the anchorage area in the river.

Only the Main Public Terminal at Boom Baru will be studied in this report. As shown in the figure 1.4, this terminal can physically be divided into two continuous wharves:

(I) Western/upstream part:

Length:	375 m, reinforced concrete
Shed:	A + B (624 + 1.171 m2), D + E (1511 + 1.131 m2) H (1.375 m2)
Yard:	at the front and behind sheds
Trade:	interinsular ship traffic, international and domestic cargo in the storage facilities.

(II) Eastern/downstream part:
Length: 360 m, reinforced concrete
Shed: (3000 m2)
Yard: - behind shed I
- the existing yard of 15.000 m2 being repaved and expanded to approximately 27.000 m2, completed by 1999
Trade: international ship traffic (mixed interinsular and international ship traffic on 100 m long quay near to the western/upstream part), international cargo in the storage area.

The natural water-depth at the front of that wharves, is about 7.00 m below LWS [7]. For the present operation, therefore, practically no maintainance dredging is required at the quay side.

The successive and step-by-step development projects have been executed in the past in order to cope with the anticipated trade growth. The last study, which included a masterplan, feasibility study, site investigation and engineering design, was carried by Haskoning, Royal Dutch Consulting Engineers in association with PT Delta Tama Waja in 1983/1984. This study mainly based on the Four Gateways Port System policy (see Annex A1), which channels all international cargo through the Gateway port (in this case: Tanjungpriok) and transhipping to/from collector ports (in this case: Palembang), which would lead to a progression of unitization of international general cargo. This policy is expected to be implemented by 1990, when the infrastructure requirement both in Tanjungpriok and Palembang to cope with the forecast throughout, will have been completed. The consultant's recomendation was to develop the so-called Multipurpose Terminal at the existing international quay, incorporates a Container Freight Station (CFS) shed, Non Container (NCC) Shed, paving area of 30.000 m2 for both container and non container cargo, the construction of new service boat jetty, and purchasing of new additional cargo handling equipments. This physical facilities development, together with technical assistance and training, for the port of Tanjungpriok, Panjang, Palembang, Telukbayur and Pontianak (within the region of Perumpel II, see Annex A4) is known as the National Ports Development Project (NPDP) cofinanced by World Bank.

However, there were three important events in 1985 which could considerably deviate the consultant's traffic forecast. First, the Pertamina has been operating a new special jetty for its aromatic product since 1985. Whereas this product was expected to be handled at the Main Public Terminal in the consultant analysis. The second major event was the oil price collapse, from 25 US $ to less than 10 US $ per barrel, within just a few months. Because the contribution of oil and natural gas was close to 70% of export revenue, obviously, this event limited considerably the availability of foreign exchange for import. The third event which brought greater impact was the introduction of the new trade policy with respect to the transportation, included Inpres 4/85, implemented since April 1985 (see Annex A2). As a result, the actual traffic flow in 1985 showed a significant deviation from the consultant's forecast (see Annex B1). In connection with this fact, the World Bank Mission visited the port of Palembang in April/May 1986. In order to accomodate the findings of the World Bank Mission, and to comply with the present situation and condition as a results and effects of the implementation of the Inpres 4/85 and all related implementation decrees, the Port Improvement Action Plan was prepared as a revision of the Port Operation Improvement Action Program, part of the implementation of the NPDP. For port of Palembang, this Action Plan covered [13]:

(I) Physical Facilities:

- The scope of project, except paving the area behind the international subterminal of approximately 27.000 m2, have been cancelled (see figure 1.5)
- Procurement of 1 (one) 2400 HP tug boat
- Rehabilitation of navigational aids along Musi river, and rehabilitation of access road to the international subterminal.

(II) Port Operation Improvement:

1. Working system (procedure).
   The improvement of cargo handling operation performance which is expected to be achieved by the introduction of effective operation planning. This includes:
   a) prearrival planning, to which the berth allocation (before the vessel's arrival) is planned based on the notification of the vessel's arrival.
   b) work schedulling, which involved the preparation of the shift-by-shift detailed planning of the cargo handling operation. This is done when the vessel is alongside the berth. The highest possible ship output and the minimum delay are expected.
   c) performance review, which mainly consist of monitoring during the cargo handling take place, and evaluation of the operation after the ship has departed.

   This systematic and routine procedure in the working system, is expected to bring the cargo handling operation more effective.
2. Working Time.
   The introduction of the new working time is expected to increase the port capacity. In the first step, it is to synchronize the different working time of the parties involved in port activity. Afterward, if it

is necessary, the multishift system as guided by Inpres 4/85 (see Annex A4) should be implemented.

(III) Management.
This includes:
a) the training of any level personnel involved in the port operation, both container and conventional terminal,
b) improvement of the equipment maintance management, and
c) establishment new monitoring and reporting system for proper port operation data/statistic.

However, this Action Plan is essensially a short-term development program, which its time horizon reaches up to 1990. Moreover, the decision as to implement this program was not backed up with a detailed study. Furthermore, the medium-term (up to 1995) and the long-term (up to 2005) development have to be established as well in order to cope with the anticipated change of future port demand.

1.2 Objectives of the study

In accordance with the above mentioned situation, the objectives of this study are formulated as follows:
(I) to review and update the traffic forecasting.
(II) to investigate the 1990 situation in line with the Action Plan implementation.
(III) to prepare solutions for the 1995 and 2005 situations, and to formulate them as medium and long-term development plans.

It is of importance, in connection with the point (III) above, to specify the study area:
(I) Problem definition.
The main problem which will be answered in this study is that concerning the port capacity: berthing, cargo handling and cargo storage. The inland transport handling capacity question is beyond this study. Less or even no attention will be given to other principal problems such as: technological changes in shipping and material handling, inland transportation networks, and navigational features. The service level problem, except that concerning ship's waiting time for berthing, will be disregarded as well.

(II) Potential solutions.
There are several alternatives of solution to achieve the required demand:
a. Institutional Improvement.
This improvement which including port reorganization,

custom procedure and documentation, labour relation and regulation and training, has been taken in line with the implementation of Inpres 4/85 and Action Plan.

b. Operational Improvement.
The improvement regarding working procedure, working time and equipment maintainance has been also covered in the Inpres 4/85 and Action Plan. The radical mechanization of cargo handling is not anticipated to take place in the future.

c. Modification of Existing Facilities.
The port operation may be improved through minor modification of the facilities and the general lay out of the port. The modification is sometimes required so as to accomodate the changes in shipping and cargo handling technology.

d. Expansion of Existing Facilities.
This alternative become necessary when the 3 (three) above alternatives cannot solve the port's problem, such as congestion (or an inadequate level of service). Extending existing quays will increase ship and cargo-handling capacity. Expansion of storage facilities will increase the storage capacity.

e. Development of New Port.
Development of entirely new facilities becomes attractive if only:
(a) the existing port is limited to accomodate any expansion, or
(b) the investment required for development of new facilities is comparable to that for expansion of existing port facilities.

The appropriate and proper solutions to improve a port capacity can be met after indentifying the port development objectives and criteria (or criterion).

(III) Port Development Objectives and Criteria.

The objective of the port development is to minimize the total port operation cost contributed by the shipscost in connection with their time spent in port, the cargo handling operation cost and the port facilities investment. Other possible objectives such as maximizing the net profit / total revenues /return on investment, and maximizing the economic impact on the hinterland are exclusively beyond this study.

In achieving the above objective, the relevant criterion to be used is the optimization of number of berth (or the length of quay), the size of storage facilities and other major fixed investments.

Other possible criteria such as minimizing the total cost of the whole transportation chains of cargo (including inland transportation) or promoting economic growth rate are considered less relevant to this study.

(IV) Port Development Strategy.
Having known the necessity of the development plan for the future situation, the port development stategy basically consists of deciding the following issues [3]:

a. How that development plan should be met - for example, by improvement of existing institutions, operations, or facilities, or construction of new facilities?
b. Where it should be met - for example, in what part of the port?
c. When it should be met.

1.3 Content of the report

This report intends to contribute to the utilization of port computer simulation technique in port planning. The outline of the contents of this report is given below:

Chapter 2 presents the traffic forecasting for each commodity class, international as well as domestic cargo. First, the total tonnage through the port was forecasted considering the expected growth rate and the anticipated hinterlands change, if any. Second, the future distribution over Main Public Terminal was estimated. Third, the future allocation to ship and packaging form were also predicted. And the fourth, the future shipcall of each ship type was calculated. And finally, the future containers traffic (in TEU) and the level of containerization were estimated.

Chapter 3 covers the utilization of the MPTSIM model for port facilities requirement calculations. First, the inevitabity of the simulation model technique, so as to have reliable result for the Main Terminal, was outlined. Second, the modelling process in the model development was described. Third, the structure and process descriptions of the MPTSIM model were given. Fourth, the simulation time was determined. Fifth, the validation output was analysed. And finally, the outputs from the experimentation of MPTSIM model were analysed so as to answer the question regarding the port facilities requirements.

Chapter 4 discusses the terminal layout preparation. First the objectives to be achieved and the criterion to be used in the layout analysis were established. Second, several layout alternatives were developed by considering on the established objectives and the limitation and condition of the port area. Third, the most favourable alternative was choosen based on the established criterion. And fourth, the masterplan layout was prepared which indicates also the possible expansion beyond 2005. And finally, the rough cost estimate of civil work in the port development phase I (for 1995, medium term) and in the port development Phase II (for 2005, long term) was calculated.

Chapter 5 contains the conclusions and recommendations (if any) regarding the port development plan as well as regarding the utilization of the computer simůlation technique.

Annex A outlines the Indonesian maritime policy, trade policy with regard to transportation, national and hintherland (South Sumatra) economy growth rate, and port administration.

Annex B presents the cargo throughput of Palembang port categorized for each commodity-class, and indication of origin and destination; ship data with regard to its arrival, length, cargo; and cargo handling operation data.

Annex C presents the analysis of shuttle ship size determination, the analysis of ship's cost in port and the analysis of future cargo handling operation.

Annex D contains the MPTSIM program written in Personal Prosim language, gives the example of input and output, and contains the summary of the experimentation-run outputs.

1.4 Terminology

In order to have better comprehension the following terms will be used in this reports:

(I) Public terminal, a terminal owned and operated by stated-owned Public Port Corporation, to handle cargo of various shipper/consignee/port users. The term of Main Public Terminal refer to the main terminal at Boom Baru, Palembang, used to distinguish it from Sailing Vessel Terminal.

(II) Special terminal, a terminal owned and operated by company other than Public Port Corporation, to handle their own cargo.

(III) Samudra: ocean-going liner service ship
Nusantara: regular liner service ship, whose principal task is to connect all regions of Indonesia
Lokal: small ships up to 200 DWT, trading up to 500 miles from their base port
Khusus: international or domestic shipping vessels carrying special cargo.

figure 1.1 The location of Palembang city in South-East Asia region.

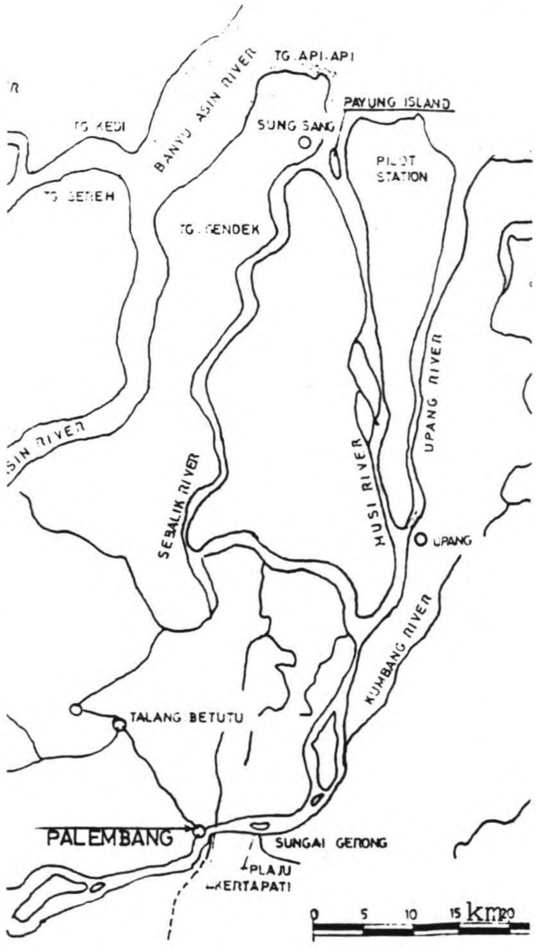


figure 1.2 The location of Palembang city in Musi river

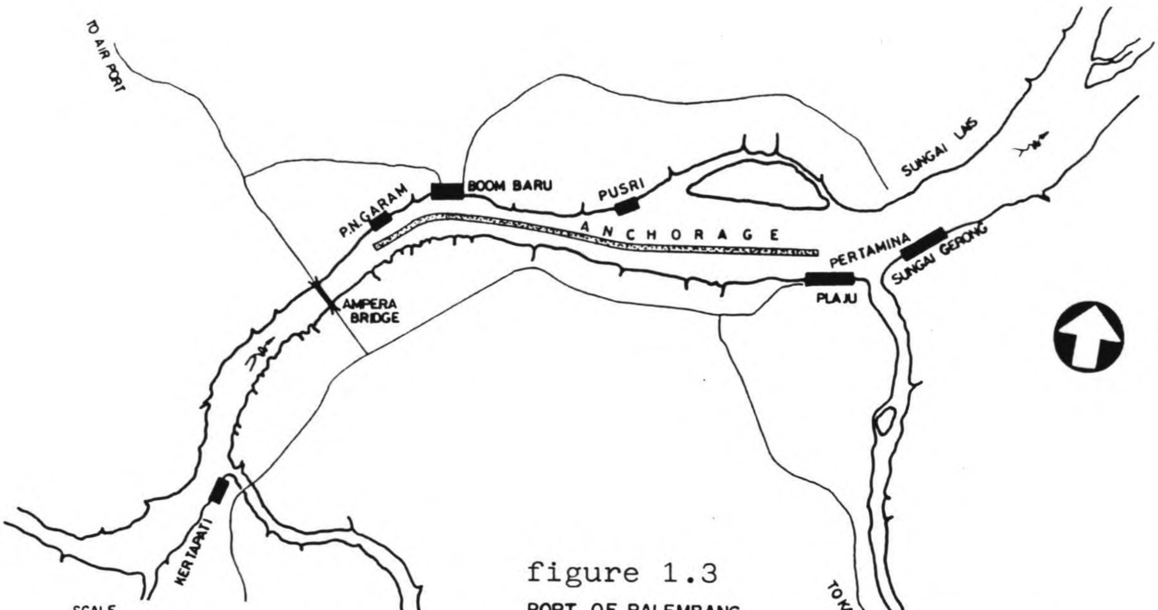


figure 1.3
PORT OF PALEMBANG
CARGO HANDLING FACILITIES

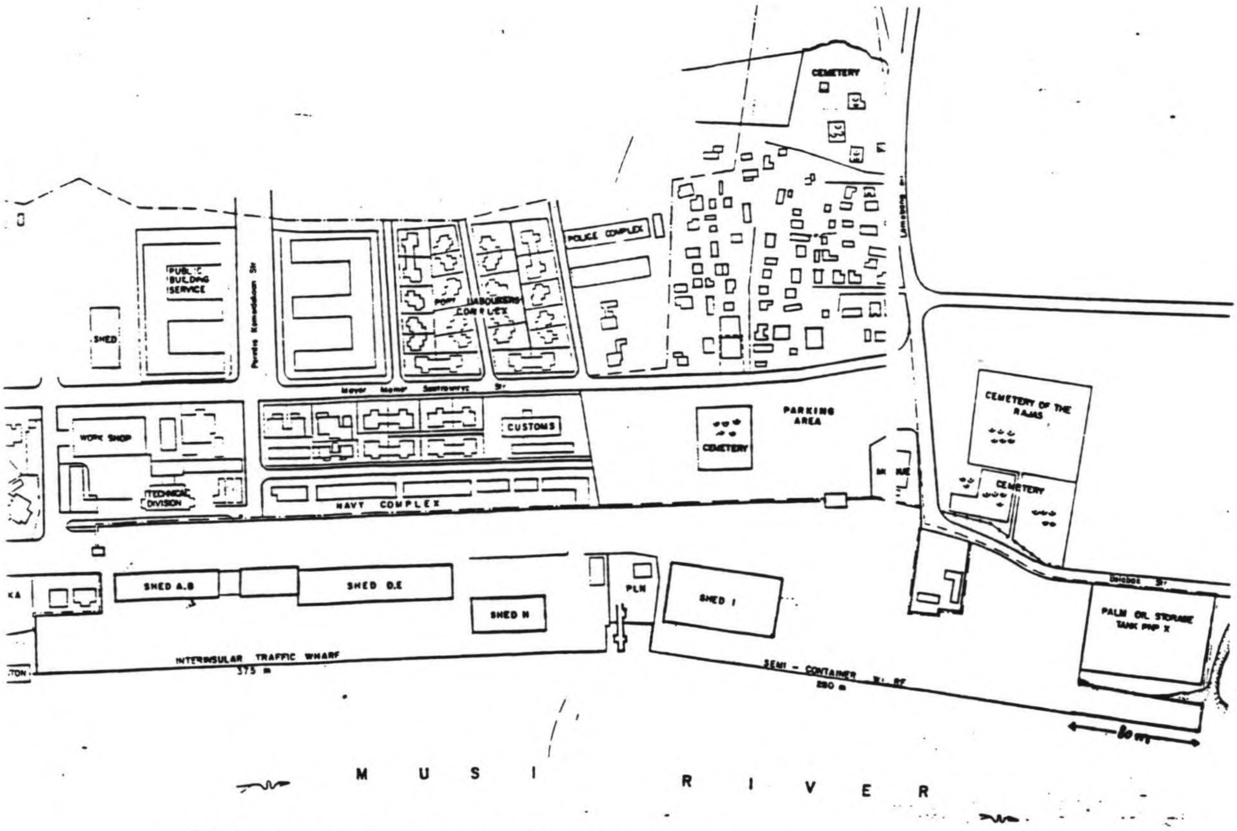


figure 1.4 The 1986 MPT layout

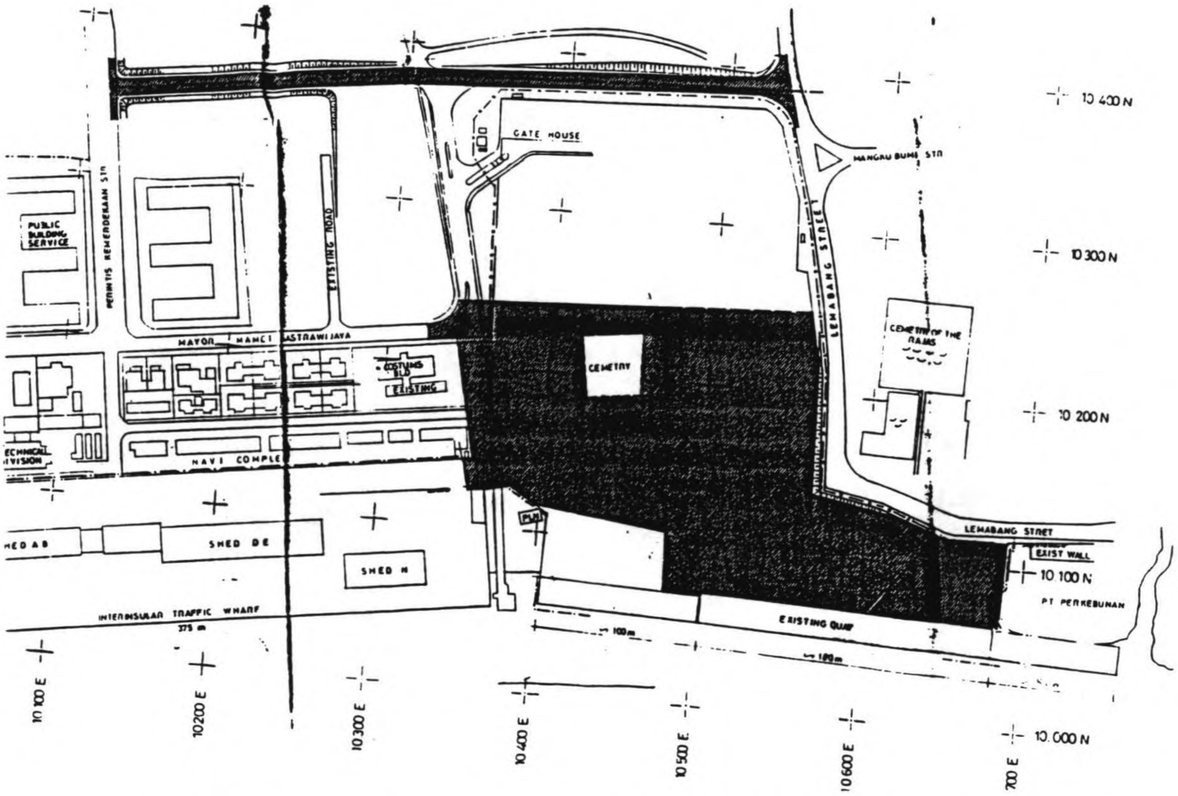


figure 1.5 The ongoing project (completed by 1989)

chapter II
TRAFFIC FORECASTING

chapter II
TRAFFIC FORECASTING

2.1 General

The objective of the trade and traffic studies was to arrive at a forecast of the most likely future traffic through Main Public Terminal, port of Palembang. The time horizon extent to 2005, with interim forecast for 1990 and 1995. The result of this analysis will be used as an input of the port simulation computer program in determining the Main Public Terminal facilities requirement.

Whereas the scope of the traffic forecasting include the following specific tasks:

- to classify the past cargo traffic, to define origin and destination, and to analyse their trends.
- to compile the port user opinion on traffic and technological trends.
- to estimate systematic traffic growth rate, based on the national and hinterland development growth rate.
- to compile the expected traffic-influencing events, incoporate the industry plans, agricultural plans and transport policies.
- to establish a most likely future growth and technological shipping scenarios of each traffic class.
- to tabulate annual forecast of each cargo class in tonnages, forecast of ship and packaging form; forecast of ship call, and forecast of container traffic.

As mentioned above, the forecasting method applied in this study was the scenario approach, which is a rigorous method of defining plausible future situations within the long-term future forecasting. The scenario can be defined as an array of anticipated events or phenomena, usually in a system of temporal and causal relationships whose sequence can generate trend on horizon scenarios.

As a collector port, Main Public Terminal handles not only an interisland cargo (domestic trade) but also an international cargo (foreign trade). Therefore, the analysis of traffic forecasting will be presented in this subdivision, although for particular cargo class, the both trade have influence on each other hence they cannot be analyzed separately.

2.2 International Trade

2.2.1 Export

The present contribution of Main Public Terminal is still very low, i.e. less than 2 percent of total export cargo through port of Palembang. The commodities and their percentage which handled through MPT in 1986 were 100 percent of animal feed, about 10 percent of coffee and about 5 percent of rubber [15]. Whereas the remainder, and also the other cargo classes, are handled midstream or at special facilities. About 80 percent of rubber and coffee was destinated to U.S.A., which was shipped by LASH service where palletized and preslung cargo is still prefered. Meanwhile there is slight increase in container traffic bound for Europe [14].

In general, the effects of implementation of Gateway policy and Inpres 4/85 are as follows:

(I) The export cargo will be carried by Shuttle ship to Tanjungpriok, except: a) rubber and coffee bound for U.S.A. which will be shipped by LASH service, and b) export cargo bound for Singapure and Malaysia which will be shipped directly by Samudra ship and c) export cargo which will still be loaded to special ship at special facilities.
In other words, the present shipping operations, which are considered more economical than if they are replaced by the implementation of Gateway port policy, are expected to continue in the future. The LASH service operates barges calling at several ports located along eastern coast of Sumatra (including port of Palembang) to take rubber and coffee, concentrates these barges at Riou islands near Singapure, and loads these barges (with their load) onto LASH ship destined to USA. This operation is basically a concentration of cargo similar to the Gateway policy. Furthermore, the implementation of Gateway policy to those cargo of short distance (Singapure and Malaysia) means approximately double traveling distance, thus the present shipping of Samudra is preferable.

(II) That situation will lead to the increasing of utilization of Main Terminal as a loading point. Obviously, there will be gradual shift of some export cargo from midstream operation. Not only coffee and rubber, but also the other food commodity, which is at present totally handled midstream.

(III) Furthermore, it is anticipated that the unitization of cargo will increase, where the containerization is likely to continue to expand in the medium scale.

(IV) Direct calling between Tanjungpriok and countries of destination will gradually diminish the present tanshipment of some export cargo at Singapure port.

With regard to hinterland change due to a strong competition with the new deep-sea port of Bengkulu, this seems only to apply for rubber and coffee, where part of plantation area is nearer to that port. These nearer plantation area include Lubuk Lingpau area and half of Lahat area, which contributed approximately 20% and 30% of South

Sumatra production of rubber and coffee respectively in 1985 [15]. Therefore it is expected that there will be diversion of 5 percent for rubber and 10 percent for coffee in 1990, and increase to 10 percent for rubber and 20 percent for coffee in 1995 onwards.

Rubber is the Indonesia's largest agricultural export commodity, with about 90 percent total production being sold abroad. In 1985, the contribution of South Sumatra was about 15 percent of total export [2]. Based on continued favourable market condition for natural rubber, it is assumed that South Sumatra will maintain its share of rubber export. Considering the declining of rubber price in world market in recent years, which will not improve within the near future, the expected growth rate of exportation of this commodity is 2.5 percent per year up to 1995 and 3.0 percent per year afterwards.

Indonesia is a large producer of coffee, at which over 90 percent of total production is exported. In 1985, the contribution of South Sumatra was about 20 percent of total Indonesian export [2]. It is assumed that South Sumatra will be capable to maintain its share of coffee export. Although there was remarkable rise of coffee price in 1986, it will seemingly not persist for a long time. It is also assumed that in the near future, the USA, the main importer of Indonesian coffee, will strengthen the protectionism policy. Therefore the anticipated growth rate of exportation of this commodity will be 2.0 percent per year up to 1995 and 2.25 percent per year afterwards.

The exportation of animal feed commodity varied irregularly in the past years. Nevertheless, the growth rate of 5 percent per year will be employed in the forecasting [7].

The present handling using Main Terminal exclusively is expected to continue.

As mentioned above, the other food commodity is at present totally handled midstream, and gradually will shift to Main Public Terminal, about 50 percent in 1990 and 100 percent in 1995. The impresive increase of exportation of this commodity was recorded in the past years, and it seems to continue in the future with the growth rate of 4.5 percent per year.

Finally, the detailed forecasting of each export commodity class in total tonnage through port, its distribution via Main Public Terminal, its allocation to ship and packaging form, is presented in table 2.1.

2.2.2 Import

The present contribution of Main Public Terminal is about 60 percent of total import cargo, which consist of almost all commodity classes. Whereas the remainder is mostly unloaded midstream [15].

In general, the similar effects of implementation of Gateway policy and Inpres 4/85 in the exportation are also applying for the importation. Except, of course, there will be no LASH service in this case. It is necessary to emphasize that the imported commodities from Singapore, which is at present about 40 percent of total import, will decrease to about (assumed) 25 percent in 1990 onwards.

The hinterland change is also anticipated, mainly due to the strong competition with the new deep-sea port of Bengkulu, and the effect of road improvement which will benefit the ferry port of Bakahuni [7]. Therefore there will be diversion to those ports, amounting to 7.5 percent from 1990 onwards for high value cargo, i.e. capital goods, consumer goods, non-ferro and other food commodities, and amounting to only 5.0 percent for other commodities.

The effort of the Indonesian government to achieve and maintain a self-sufficiency of food, and the effect of good interisland transportation service, will eventually stop the importation of rice. Meanwhile, the Baturaja cement plant production capacity of 500.000 tons per year and the inauguration of two new sugar factories in Cinta Manis with combined production of 80.000 tons per year, not only will stop the unloading of these two commodities, but also will generate some outgoing of these commodities to the local destination [7]:

On the other hand, the effort to stimulate a high growth of the manufacturing sector, will increase the importation of capital goods and raw material. Furthermore, the importation of consumption goods will be restricted only to products not produced domestically.

The importation of fertilizer in the future is expected to cease. Although the use of fertilizer will increase rapidly in line with the extensive and even the intensive farming methods, the establishment of fertilizer plants in the last decade has made Indonesia a net exporter of especially urea fertilizer, after having been an importer for many decades before [2]. In the future, the urea fertilizer for South Sumatra will be sufficed by PT Pusri's production, whereas the other fertilizers, such as TSP and DAP, will have to be ordered from Gresik, East Java [7]. Therefore, the incoming fertilizer is expected from interisland trade. This anticipation agrees well with the past data, where the fertilizer import showed decrease from 19.000 MT in 1982 to only 1000 MT in 1986, and domestic incoming showed otherwise, increasing from 17.500 MT in 1982 to 49.000 MT in 1986. Apparently, the fertilizer import was gradually replaced by the domestic incoming trade.

In addition, the commodity group of sand and stone, which in the future will consist for a large part of gypsum, probably will arrive directly from its country of origin in special vessel. Therefore in the forecasting, it is allocated to midstream/special facilities [7].

On the other hand, the iron and steel commodity class, will change otherwise [7]. The improvement of cargo handling capability at Main Terminal will gradually attract this commodity, which is at present totally handled midstream, amounting to 50 percent in 1990 and 100 percent in 1995 onwards.

Finally, in the future there will be 9 (nine) commodities which will be imported through Main Terminal with their expected growth rate per year in bracket [7], i.e.: animal feed (6 percent), consumer goods (8 percent), non-ferro (4 percent), capital goods (8 percent) iron and steel (4 percent), other foods (5 percent), chemicals (5 percent), asphalt (8 percent), and rubber product (8 percent).

Finally, the detailed forecasting of each import commodity class in total tonnage throughport, its distribution via Main Public Terminal, its allocation to ship and packaging form, is presented in table 2.2.

2.3 Domestic Trade

2.3.1 Domestic Outward

The present contribution of Main Public Terminal is very low, i.e. about 1.5 percent of total domestic cargo loaded through port of Palembang [15]. Whereas the remainder are handled midstream or at other facilities. The present hinterland and the distribution of cargo loading over facilities will seemingly not change in the future [7]. Therefore it is anticipated that there will be no diversion to neighbour ports or to other loading facilities.

Because the establishment of additional fertilizer production unit of PT Pusri is likely not feasible [7], the forecasting is therefore merely based on its capacity of 1.600.000 tons per year. Some of bagged fertilizer is then loaded at Main Public Terminal to be shipped to the local destination. As mentioned earlier, the Baturaja cement plant production and the Cinta Manis sugar factories production will generate some outgoing of cement and sugar commodities to the local destination. Based on information from industrial representatives and port users [7], the growth rate of 10 (ten) commodities which will partly or totally loaded through Main Public Terminal are indicated within following brackets: fertilizer (zero), cement (8 percent), sugar (11 percent) non-ferro (4 percent), capital goods (8 percent), other foods (8 percent), chemical (5 percent), timber (-1.0 percent), sand/stone (3 percent), and oil fats (5 percent). The tonnage of timber will decrease mainly due to the conversion from raw material to more finished products. But that conversion will also benefit the Main Public Terminal, that is, will incease its contribution.

With regard to ships, there are 2 (two) types of vessels which carry domestic outward cargo from Main Terminal: Nusantara and Lokal. The assessment of the 1982 allocation cargo to Nusantara and Lokal are 60% and 40% respectively [7]. It seems that this percentage distribution is unlikely to continue in the future.

Furthermore, the packaging form of cargo is distinguished based on cargo handling speeds per ganghour into 3 (three) groups: (I) bagged (19 tons/ganghour), (II) loose/breakbulk/pallet (15 tons/ganghour) and (III) drums, timber, bulk (10 tons/ganghour) [7].

Finally, the detailed forecasting of each domestic outward commodity class in total tonnage through port, its distribution via Main Public Terminal, its allocation to ship and packaging form, is presented in table 2.3.

2.3.2 Domestic Inward

The present contribution of Main Public Terminal is about 30 percent of total domestic inward cargo through port of Palembang, which consists of almost all commodity classes. Whereas the remainder is handled midstream or at other facilities [15].

The hinterland change is anticipated, because of the competition with the new deep-sea port of Bengkulu, and the effect of improvement of the road network and the ferry service [7]. The reduction owing to the first cause which is 25 percent in 1990 and 5 percent in 1995 onwards, apply for all commodities. The same reduction is brought about by the second cause, but only added to high value commodities: consumer goods, non-ferro, capital goods and other foods.

As mentioned earlier, the unloading of cement and sugar will stop because of the self-sufficiency of this region of these commodities in the future. Whereas the TSP and DAP fertilizer, which is not produced locally, will have to be unloaded from Gresik (Surabaya). The domestic unloading of rice will also increase, because the population growth can not be catered for by local harvests. The high increase of unloading salt is caused by the growing development of the fishing industry in the region. Finally, there will be 15 (fifteen) domestic commodities unloaded at Main Terminal, indicated with their growth rate [7], i.e.: fertilizer (13%), rice (2%), salt (7%), animal feed (6%), wheat flour (3.5%), consumergoods (8%), non-ferro (4%), capital goods (8%), iron/steel (4%), other foods (5%), chemicals (5%), oil fats (8%), asphalt (6%), sand/stone (3%), and livestock (5%).

With regard to the distribution of each commodity over facilities, it seems that the present situation will continue in the future.

There are 3 (three) type of vessels carrying domestic inward cargo to Main Terminal, i.e.: Nusantara, Lokal and

Khusus. The allocation of trade to Khusus vessels is straight forward, that is rice and oil fats. Whereas the present percentage distribution over Nusantara and Lokal are 60% and 40% respectively, but it seemingly will not continue in the future.

The grouping of the packaging form in the domestic outward cargo also apply for domestic inward cargo.

Finally, the detailed forecasting of each domestic inward commodity class in total tonnage through port, its distribution via Main Public Terminal, its allocation to ship and packaging form, is presented in table 2.4.

2.4 Ship Arrival Forecasting

First, the size of the shuttle ship should be determined. The analysis of the consultant has been adopted, where the economical size of this vessel is about 4000 DWT, based on the assumption that this vessel will be only used for shuttle service between Tanjungpriok and Palembang, and the cargo handling rate in port of about 2000 ton per day (see Annex C1). Moreover, this size agree with the technical requirement, where the economically limited depth of navigational channel along Musi river is about -7 m LWS. Furthermore the barge which will bring some of the exported rubber to the terminal (about 20% in 1990, 15% in 1995 and 10% in 2005 of the total exported rubber through Main Public Terminal) should also be determined. The average size of 180 DWT, similar to the barge which is at present rendering midstream operation, is assumed for that rubber barge [7].

The amount of annual cargo, which will be carried by each type of vessel, is found by summarizing the previous trade forecasting. The average cargo loaded and unloaded to/from each type of vessel is determined based upon the past data. A small increase of this average load in the future is assumed. Finally the number of annual arrival for each type of vessel is derived by dividing the amount of annual cargo by average load. The result of this calculation is presented in table 2.5.

2.5 Container Traffic

Import cargo arriving in container has to be stripped (in CFS shed or yard), and loaded onto trucks in conventional form for destinations in Palembang and further inland. Export cargo arrives at international subterminal on trucks in conventional form or on pallets has to be stuffed (in CFS shed or yard) into container for overseas destinations. The import container just stripped cannot always be used for stuffing exports due to different ownership, planned onward destinations, unsuitable container type, etc. Therefore, it is assumed that approximately 10% of import containers is an empty containers for the stuffing export cargo. The number of empty containers, furthermore, should be calculated based upon the (un)balance of export and import trade in container. The average load factor of a twenty feet container with import cargo will usually be about 10.5 ton per TEU [7]. Meanwhile, the average load factor for export cargo (which mainly consist of rubber in pallets and coffee in bags) is approximated about 14 ton per TEU [7]. With figure above, the following estimate of the total number of loaded and empty containers is made, which have to be handled by international subterminal in 1990, 1995 and 2005.

In 1990

```
- Import 21.500 = 2050 loaded container add 200
           10.5     empty = 2250 TEU

- Export  9.500 =  680 loaded container add 1570
            14      empty = 2250 TEU
         ____________________________________________
  Total   1.990     flow  = 4500 TEU
```

In 1995

```
- Import 38.000 = 3600 loaded containers add
            10.5        400 empty containers = 4000 TEU
- Export 38.500 = 2750 loaded containers add
            14         1250 empty containers = 4000 TEU

                       Total 1995 flow         8000 TEU
```

In 2005

```
- Import 91.000 = 8670 loaded containers add
            10.5        830 empty containers = 9500 TEU
- Export 123.500= 8820 loaded containers add
            14          680 empty containers = 9500 TEU

                       Total 2005 flow        19000 TEU
```

Summary:

It is assumed that 10% of loaded containers in 1995 and 30% of loaded containers in 2005 will be stripped and stuffed directly. It implies that the stripped/stuffed general cargo will not stay in port before stripping or stuffing is carried out. This kind of containers may be door-to door FCL or direct stripped/stuffed LCL. Furthermore it is assumed the transit time of containers carrying import cargo, containers carrying export cargo, empty containers and containerized general cargo in CFS shed is about 7, 5, 20 and 7 days respectively [20].

Finally, it is of importance to check the level of containerization. By taking the containerisability of 100% for rubber, rubber product, coffee, animal feed and other foods, of 90% for consumer goods, of 75% for chemical, of 50% for non-ferro and capital goods, and of 0% for iron/steel and asphalt [6], the percentage of containerization in 1986 and in the future are estimated below:

year	1986	1990	1995	2005
Export & Import through Main Public Terminal (in 1000 MT)	88.5	132.5	222	437
Contanerizable cargo (in 1000 MT)	65.5	89	1605	312.5
Containerized cargo (in 1000 MT)	14.5	31	76.5	214.5
Containerization (%)				
- of export & import cargo	16	23	35	49
- of containerizable cargo	22	35	48	69

The above percentage of containerization fits with the earlier anticipation that the containerization will continue to expand to the medium level.

Table 2.1. The Export Cargo Forecasting

No	COMMODITY CLASS	VIA PORT OF PALEMBANG					VIA MAIN TERMINAL					Shuttle / Samudra															remark
												container					Pallet					Break Bulk					
		85	86	90	95	05	85	86	90	95	05	85	86	90	95	05	85	86	90	95	05	85	86	90	95	05	
1.	Rubber	165	168	180	200	219	8	10	18	50	110			4	20	70			8	20	24						sh
												3	3	1	3	8	5	7	3	7	8						sa
2.	Coffee	60.5	81.5	68	67	84	6	8	8	12	21			2	6	16			6	6	5						sh
												1	2	-	-	-	5	6	-	-	-						sa
3.	Animal Feed	7	3	4	5	8	7	3	4	5	8			1	2	6.5			2	2	-						sh
												-	-	-	0.5	1.5	7	3	1	0.5	-						sa
4.	Other food	15	18.5	22	27.5	42.5	-	-	11	27.5	42.5			1	5	16			7	15.5	16						sh
												-	-	0.5	2	5.5	-	-	2.5	5	5						sa
	Total	47.5	271	274	299.5	353.5	21	21	41	94.5	181.5			8	33	108.5			25	43.5	45						sh
												4	5	1.5	5.5	15	17	16	16.5	12.5	13						sa

sh = shuttle

sa = Samudra

sh = shuttle kh = khusus

sa = Samudra

Table 2.2. The Import Cargo Forecasting

No	COMMODITY CLASS	VIA PORT OF PALEMBANG					VIA MAIN TERMINAL					Shuttle					Samudra										remark
												container					Pallet					Break Bulk					
		85	86	90	95	05	85	86	90	95	05	85	86	90	95	05	85	86	90	95	05	85	86	90	95	05	
1.	Animal feed	2	2	2.5	3	6	2	2	2.5	3	6			1	1.5	4.5			1.5	1.5	1.5						sh
												0.5	0.5				1.5	1.5									sa
2.	Consumer goods	12.5	16	20	30	64	8	12	15	22	48			2	7.5	24			8	7.5	8						sh
												1	1.5	1	3.5	12	7	10.5	4	3.5	4						sa
3.	Non ferro	2.5	2	2.5	3	4	2.5	2	2.5	3	4			1	1.5	2			1.5	1.5	2						sh
																	2.5	2									sa
4.	Capital goods	20	15	19	28	60	8	10	16.5	24.5	52.5			3.5	5	11			3.5	5	11			7	11	23	sh
												-	1	0.5	0.5	1.5	4	4	0.5	1	2	4	5	1.5	2	4	sa
5.	Iron and steel	12.5	7.5	8.5	10	15	-	-	8.5	10	15													8.5	10	15	sh
																											sa
6.	Other foods	17.5	16.5	15	19	31	5	10	12	15	24			7	8	14			2	3	5						sh
												1	3.5	2	3	3.5	3	6.5	1	1	1.5						sa
7.	Chemical	10	12.5	14.5	18.5	30	10	12.5	3.5	4.5	7.5			1	1.5	2.5			1	1.5	2.5						sh
												1	2	0.5	0.5	1	9	10.5	1	1	1.5						sa
8.	Rubber product	5	6	8	11.5	24.5	5	6	8	11.5	24.5			1.5	4	13			4.5	4.5	5.5						sh
												0.5	1	0.5	1.5	2	4.5	5	1.5	1.5	4						sa
9.	Asphalt	28.5	13	23	34	74	28.5	13	23	34	74																kh
	Total	130.5	96.5	113	157	308.5	69	67.5	91.5	127.5	255.5			17	29	71			22	24.5	35.5			15.5	21	38	sh
												4	9.5	4.5	9	20	31.5	40	8	8	13	4	5	1.5	2	4	sa

Table 2.3. The Outward Domestic Cargo Forecasting

(1000 MT)

No	COMMODITY CLASS	VIA PORT OF PALEMBANG					VIA MAIN TERMINAL					Nusantara Lokal Ship: Bag					Pallet/Loose/B.b.					Others					
		85	86	90	95	05	85	86	90	95	05	85	86	90	95	05	85	86	90	95	05	85	86	90	95	05	
1.	Fertilizer (bag)	153	116.5	200	200	200	2.5	2	3	3	3																Nu
												2.5	2	3	3	3											Lo
2.	Cement	7.5	4.5	6	9	19	0.5	0.5	0.5	0.5	1																Nu
												0.5	0.5	0.5	0.5	1											Lo
3.	Sugar	-	2.5	4	6	18	-	0.5	1	2	8																Nu
												-	0.5	1	2	8											Lo
4.	Non ferro	0.1	1.5	1.5	2	3	-	0.5	0.5	1	2						-	0.5	0.5	0.5	1						Nu
																	-	-	-	0.5	1						Lo
5.	Capital goods	1	2.5	3.5	5	10	0.5	1	1	1.5	3																Nu
												0.5	1	1	1.5	3											Lo
6.	Other foods	4.5	(10)	12	14	23	0.5	1	1.5	2	4																Nu
												0.5	1	1.5	2	4											Lo
7.	Chemical	3	(5)	6	8	12.5	1.5	2	3	4	8											1.5	2	3	5	8	Nu
																											Lo
8.	Timber	18.5	191.5	190	175	158	4.5	4,5	5	5	5											3.0	3.0	3.5	3.5	3.5	Nu
																						1.5	1.5	1.5	1.5	1.5	Lo
9.	Sand and Stone	2	(4)	4.5	5	7	2	4	4,5	5	7						1	2	2.5	2.5	3.5						Nu
																	1	2	2	2.5	3.5						Lo
10.	Oil fats	18.5	15.5	19	24	39	5	4	5	6	10											2.5	2	2.5	3	5	Nu
																						2.5	2	2.5	3	5	Lo
		375	353.5	4465	448	489.5	17	20	25	29.5	51	-	-	-	-	-	1	2.5	3	3	4.5	7	7	9	10.5	16.5	Nu
												3.5	4	6	7.5	16	1.5	3	3	4.5	7.5	4	3.5	4	4.5	6.5	Lo

Table 2.4. The Inward Domestic Cargo Forecasting

No	COMMODITY CLASS	VIA PORT OF PALEMBANG					VIA MAIN TERMINAL					Nusantara					Lokal Ship)										
												Bag					Pallet/Loose/B.b.					Others					
		85	86	90	95	05	85	86	90	95	05	85	86	90	95	05	85	86	90	95	05	85	86	90	95	05	
1	Fertilizer	49.5	48	76	137	465	30	30	495	98	302	30	30	495	89	302											Nu
												-	-	-	-	-											
2	Rice	76	119.5	127	137	167	36	59.5	62	63	75	24	24	24	24	28											Nu
												-	-	-	-	-											Lo
												12	35.5	38	38	47											Kh
3	Salt	30	33.5	43	58	113	5	5.5	7	10	20	5	5.5	7	10	20											Nu
												-	-	-	-	-											Lo
4	Animal feed	3	4	5	6	11	1	1	1.5	1.5	3	-	-	-	-	-											Nu
												1	1	1.5	1.5	3											Lo
5	Wheat flour	28	32	36	41	58	11	13	15	17	24	2	2	2.5	2.5	3.5											Nu
												9	11	12.5	14.5	20.5											Lo
6	Consumer goods	19	23	29.5	41.5	89.5	7	8.5	10.5	15	37						4.5	5.5	7	10	24						Nu
																	2.5	3	3.5	5	13						Lo
7	Non ferro	15.5	18	20	23	34	11	12.5	14	16	24						7.5	8.5	9.5	11.5	17						Nu
																	3.5	4	4.5	5.5	7						Lo
8	Capital goods	11	12	15.5	21.5	46.5	5	5	6.5	9	19						3.5	3.5	4.5	6.5	14						Nu
																	1.5	1.5	2	2.5	5						Lo
9	Iron and steel	35.5	(36)	41	49	72	20	20	23	28	40						5	5	6	7	10						Nu
																	15	15	17	21	30						Lo
10	Other foods	21	22.5	26	31.5	51	10	11	13	16	25	6	6.5	7.5	9	15											Nu
												4	4.5	6.5	7	10											Lo
11	Chemicals	4	5.5	6.5	8	13	2	25	3	4	6											1	1.5	1.5	2	3	Nu
																						1	1	1	2	3	Lo
12	Oil fats	16.5	17	22.5	32	70	15	15	20	28	63											2	2	3.5	4.5	10.5	Nu
																						2.5	2.5	4	5.5	12.5	Lo
																						10.5	10.5	12.5	18	40	Kh
13	Asphalt	13	(17)	21	27	49	4	5	7	9	16											4	5	7	9	16	Nu
																						-	-	-	-	-	Lo
14	Sand/Stone	36	(30)	33	37	50	8	8	8	8	17						4	4	4	4	6						Nu
																	4	4	4	4	6						Lo
15	Livestock	2	2	2.5	3	5	2	2	2.5	3	5											-	-	-	-	-	Nu
																						2	2	2.5	3	5	Lo
		360	420	504.5	652.5	1294	167	196.5	242.5	315.5	671	67	68	90.5	134.5	368.5	24.5	26.5	31	39	71	7	8.5	12	15.5	29.5	Nu
												13	16.5	20.5	23	33.5	26.5	27.5	31	38	61	5.5	5.5	7.5	10.5	20.5	Lo
												12	35.5	38	47	-	-	-	-	-	-	10.5	10.5	12.5	18	40	Kh

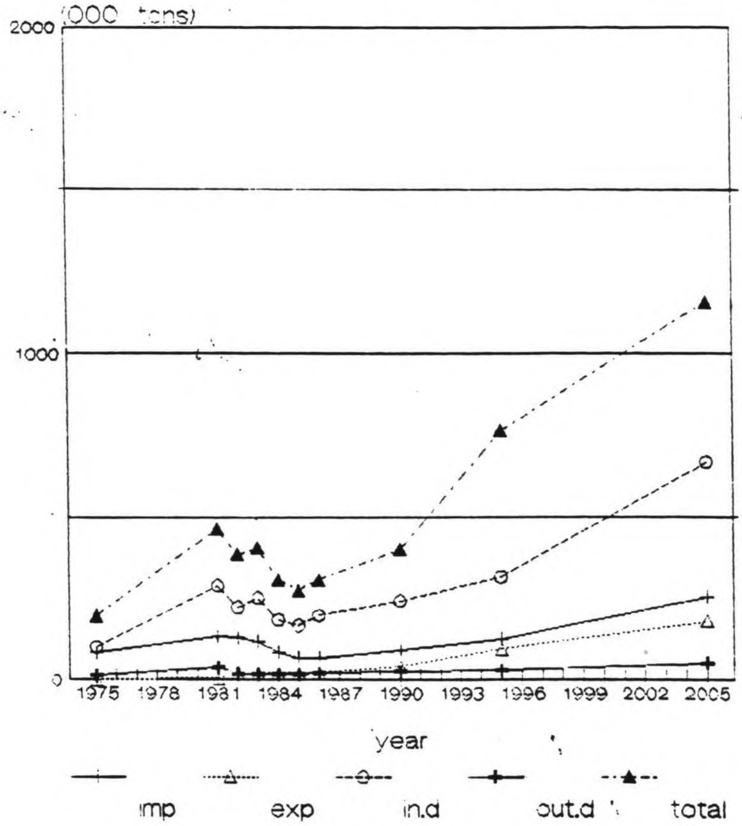
*) and Khusus ship in third row, especially for rice and oil fats.
Nu = Nusantara
Lo = Lokal
Kh = Khusus

Table 2.5. Summary of Trade Forecast and ship Arrival Forecasting

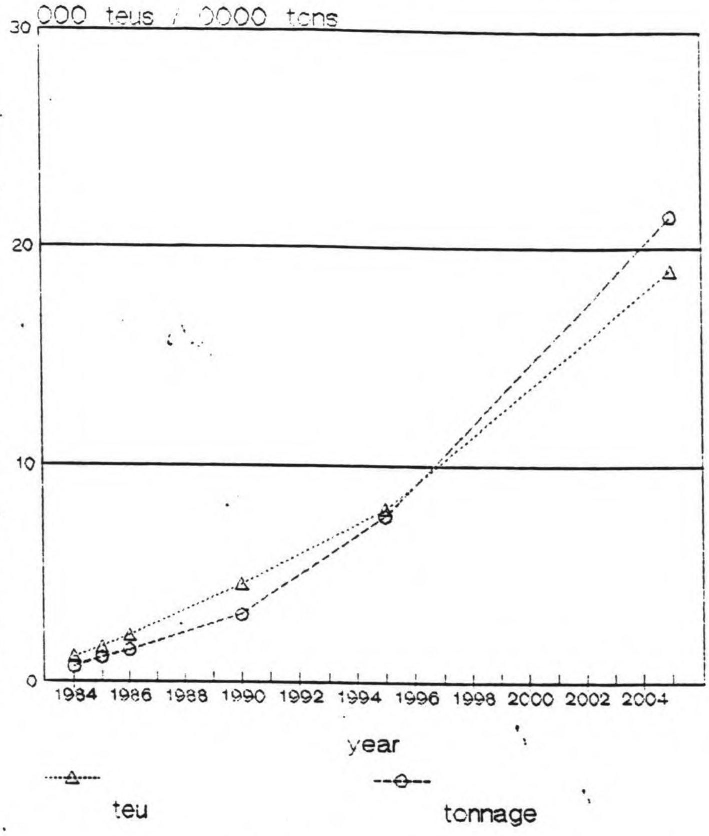
Trade	Ship (DWT)		CARGO FLOW: Loading (L) / Unloading (U) / Subtotal (ST) (1000 MT) — container					pallet					break bulk					others				
			85	86	90	95	05	85	86	90	95	05	85	86	90	95	05	85	86	90	95	05
International	1 Shuttle (4000)	L	-	-	8	33	108.5	-	-	25	43.5	45	-	-	-	-	-					
		U	-	-	17	29	71	-	-	22	24.5	35.5	-	-	15.5	21	38					
		ST	-	-	25	62	179.5	-	-	47	68	80.5	-	-	15.5	21	38					
	2 Samudra (1900)	L	4	5	1.5	5.5	15	17	16	16.5	12.5	13	-	-	-	-	-					
		U	4	9.5	4.5	9	20	31.5	40	8	8	13	4	5	1.5	2	4					
		ST	8	4.5	6	14.5	35	48.5	56	24.5	20.5	26	4	5	1.5	2	4					
	3 Khusus Internat. (1800)	L																-	-	-	-	-
		U															(Drum)	28.5	13	23	34	74
		ST																28.5	13	23	34	74
	4 Rubber Barge (180)	L															(Loose)	-	-	3.5	7	11
		U																-	-	-	-	-
		ST																-	-	3.5	7	11
	TOTAL	L	4	5	9.5	38.5	123.5	17	16	41.5	56	58	-	-	-	-	-	-	-	3.5	7	11
		U	4	9.5	21.5	38	91	31.5	40	30	32.5	48.5	4	5	17	23	42	28.5	13	23	34	74
		ST	8	14.5	31	76.5	214.5	48.5	56	71.5	88.5	106.5	4	5	17	23	42	28.5	13	26.5	41	85
Domestic			bag					pallet/loose/B.b.					others									
			85	86	90	95	05	85	86	90	95	05	85	86	90	95	05					
	1 Nusantara (600)	L	-	-	-	-	-	1	2.5	3	3	4.5	7	7	9	10.5	16.5					
		U	67	68	90.5	134.5	368.5	24.5	26.5	31	39	71	7	8.5	12	15.5	29.5					
		ST	67	68	90.5	134.5	368.5	25.5	29	34	42	75.5	14	15.5	21	26	46					
	2 Lokal (180)	L	3.5	4	6	7.5	16	1.5	3	3	4.5	7.5	4	3.5	4	4.5	6.5					
		U	13	16.5	20.5	23	33.5	26.5	27.5	31	38	61	5.5	5.5	7.5	10.5	20.5					
		ST	16.5	20.5	26.5	30.5	49.5	28	30.5	34	42.5	68.5	9.5	9	11.5	15	27					
	3 Khusus Domestic (1800)	L	-	-	-	-	-						-	-	-	-	-					
		U	12	35.5	38	38	47						10.5	10.5	12.5	18	40					
		ST	12	35.5	38	38	47						10.5	10.5	12.5	18	40					
	TOTAL	L	3.5	4	6	7.5	16	2.5	5.5	6	7.5	12	11	10.5	13	15	23					
		U	92	120	149	195.5	449	51	54	62	77	132	23	24.5	32	44	90					
		ST	95.5	124	155	203	465	53.5	59.5	68	84.5	144	34	35	45	59	113					

Trade	Ship (DWT)	Total Cargo per year (1000 MT)					Tons/call					Call/year				
		85	86	90	95	05	85	86	90	95	05	85	86	90	95	05
International	1 Shuttle (4000)	-	-	87.5	151	298.5	-	-	3600	4000	4400	-	-	25	38	68
	2 Samudra (1900)		(73.5) 105	32	37	65		550	560	570	580		190	58	65	112
	3 Khusus Internat. (1800)		13	23	34	74		640	650	675	700		20	36	51	106
	4 Rubber Barge (180)		-	3.5	7	11		-	50	50	50		-	70	140	220
	TOTAL															
Domestic	1 Nusantara (600)		(112.5) 83	145.5	202.5	490		320	350	975	400		259	416	540	1225
	2 Lokal (180)		60	72	88	145		177	180	180	180		334	400	489	806
	3 Khusus Domestic (1800)		46	50.5	56	87		640	650	675	700		72	78	83	125
	TOTAL		307	414	575.5	1170.5							875	1083	1406	2662

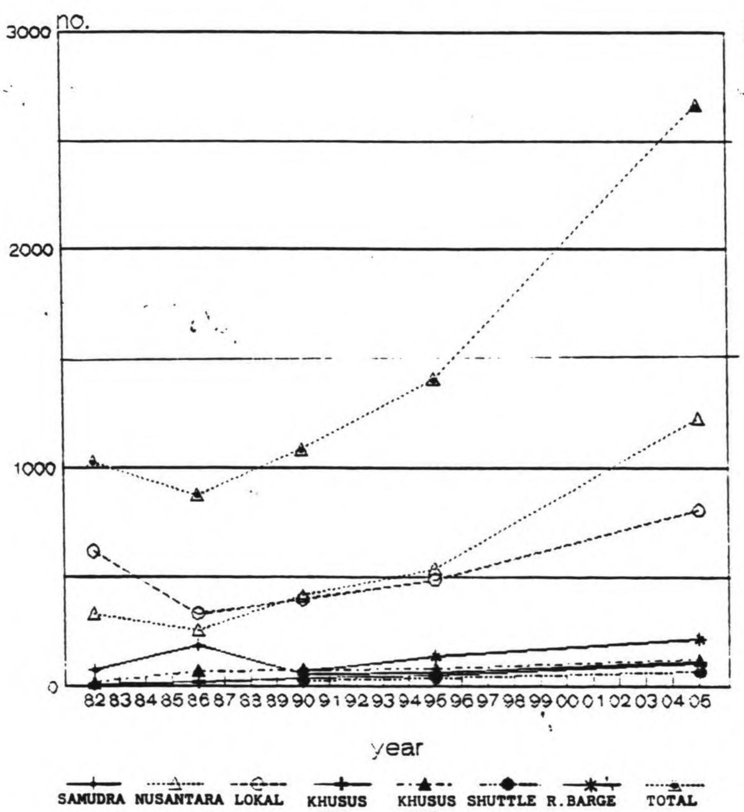
main public terminal
1975/2005 cargo throughput



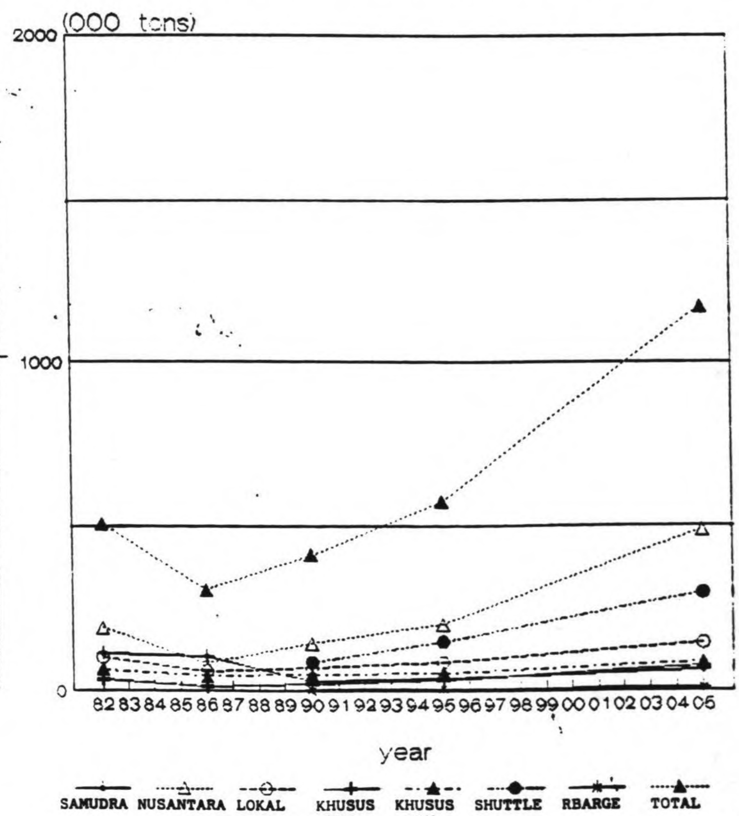
main public terminal
1984/2005 container traffic



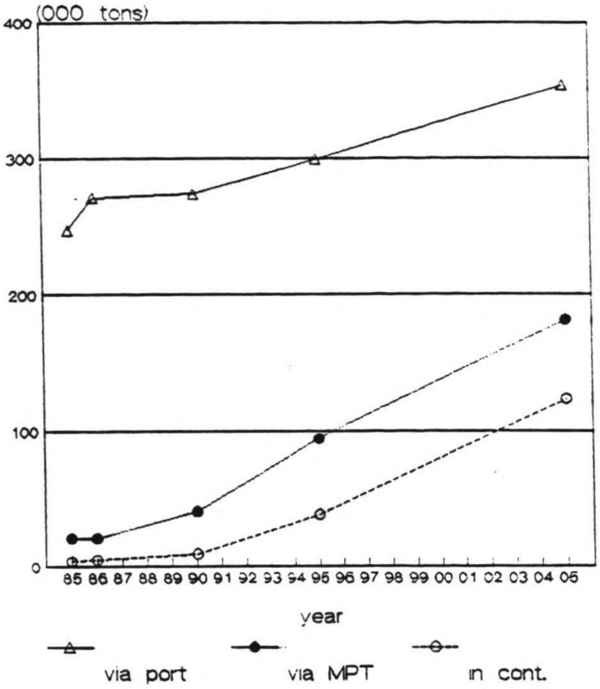
main public terminal
1982/2005 annual shipcall



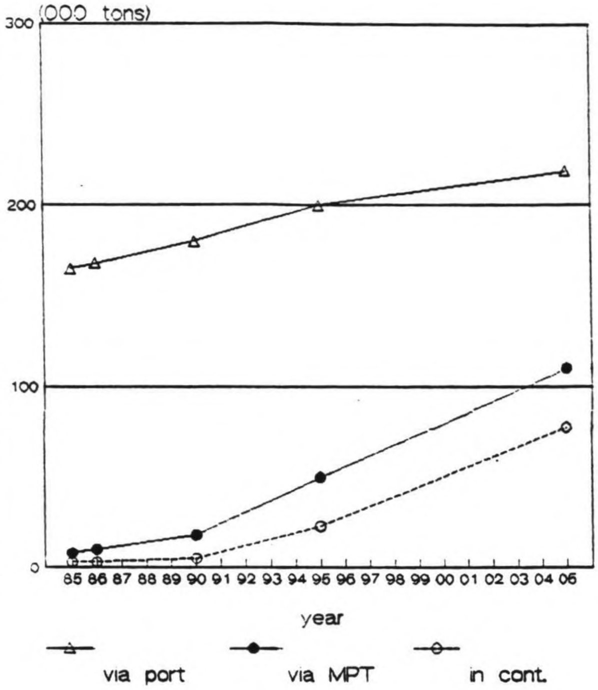
main public terminal
1982/2005 cargo carried by ship



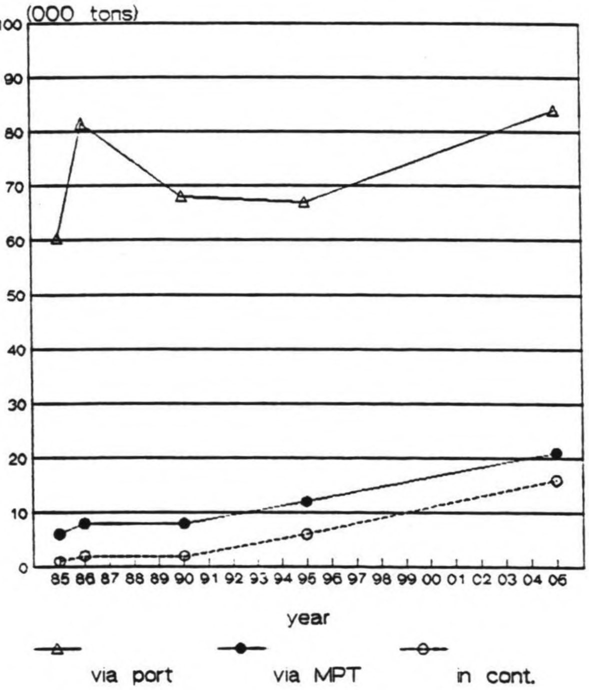
main public terminal
export : all commodities



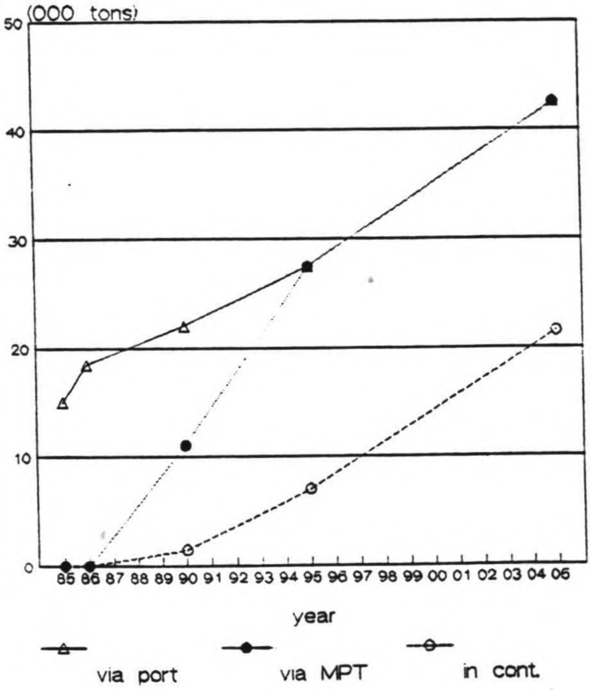
main public terminal
export : rubber

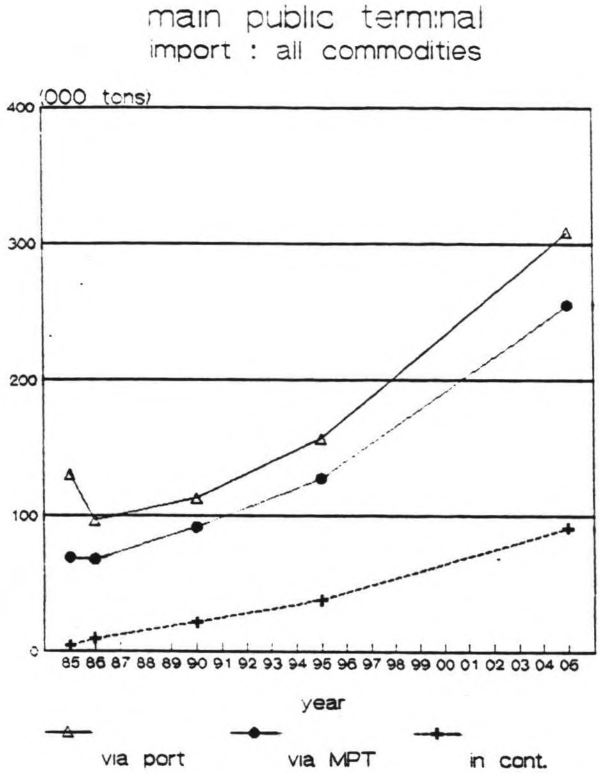


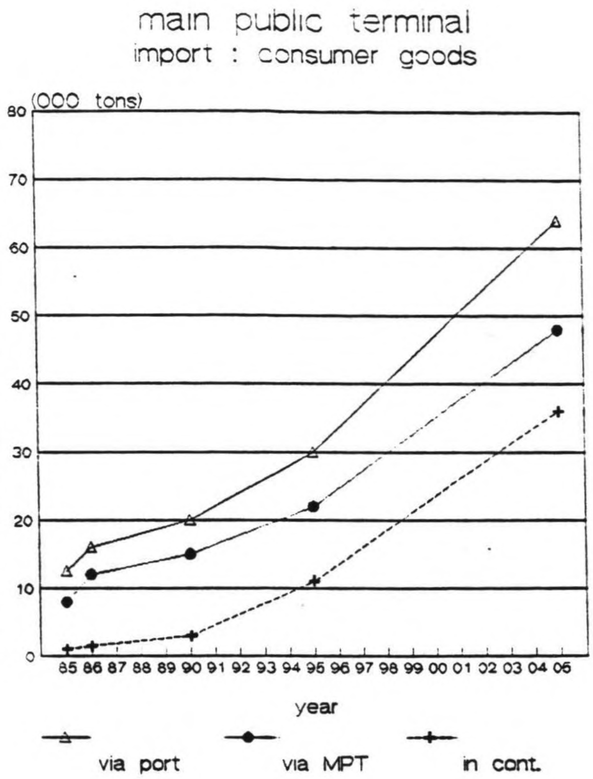
main public terminal
export : coffee

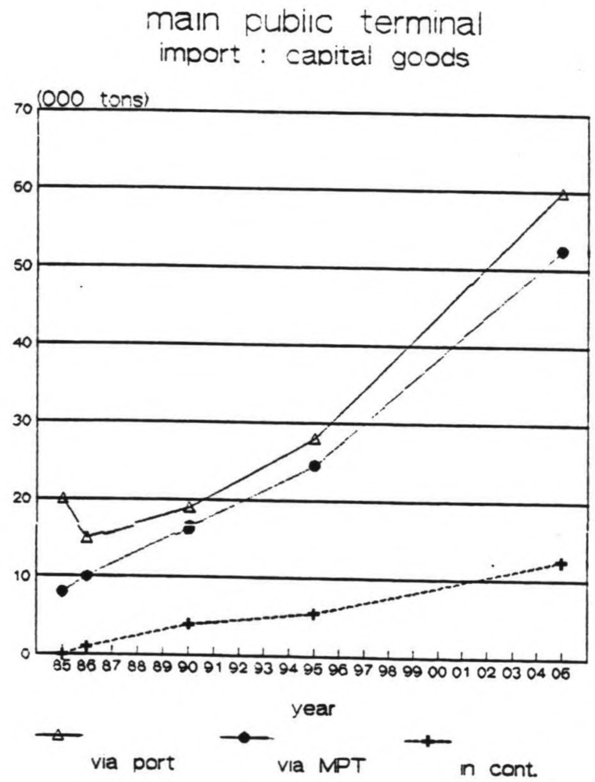


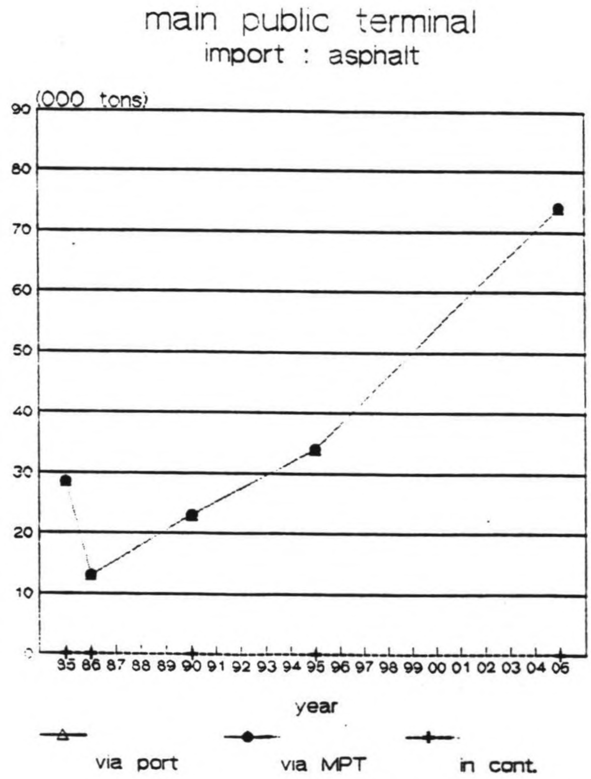
main public terminal
export : other food

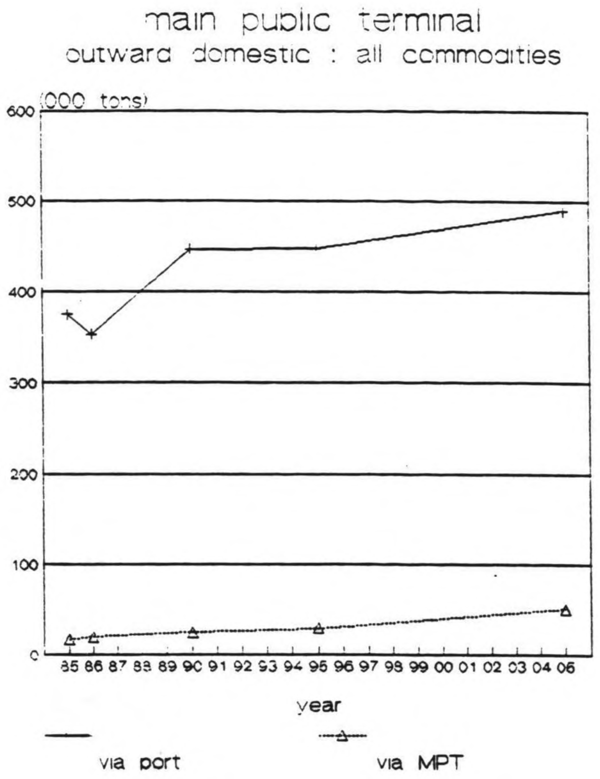



main public terminal
import : all commodities
(000 tons)
400
300
200
100
0
85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 06
year
via port
via MPT
in cont.

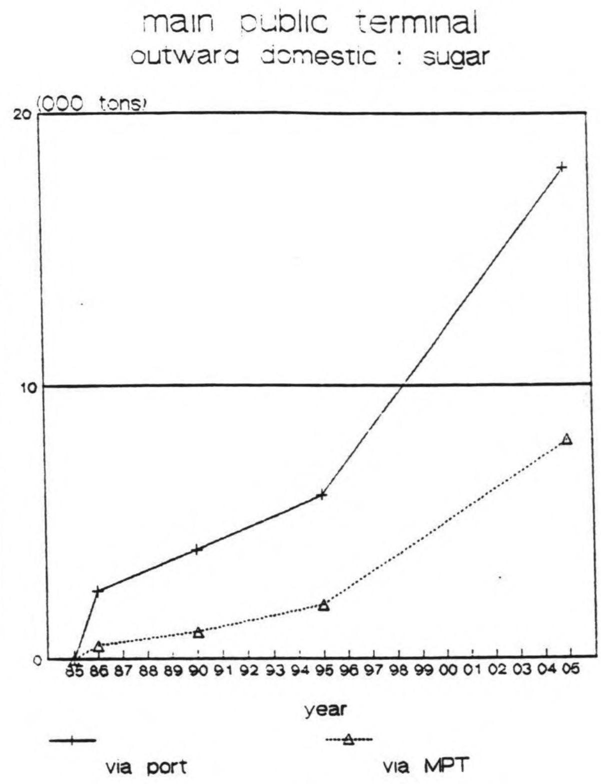

main public terminal
import : consumer goods
(000 tons)
80
70
60
50
40
30
20
10
0
85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 06
year
via port
via MPT
in cont.


main public terminal
import : capital goods
(000 tons)
70
60
50
40
30
20
10
0
85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 06
year
via port
via MPT
in cont.

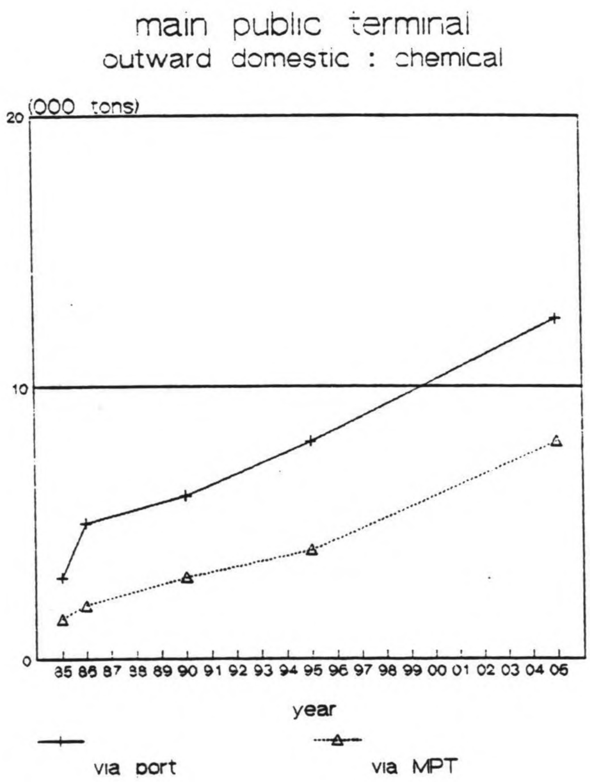

main public terminal
import : asphalt
(000 tons)
90
80
70
60
50
40
30
20
10
0
85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 06
year
via port
via MPT
in cont.



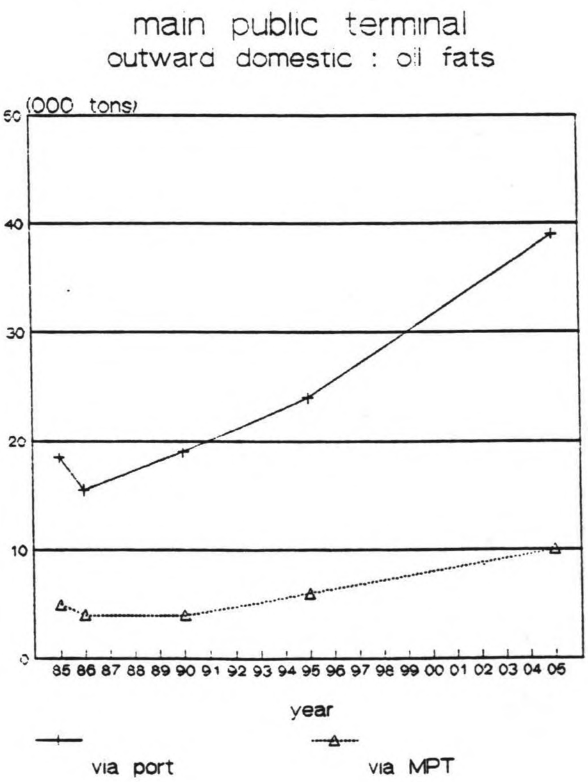
main public terminal
outward domestic : all commodities
(000 tons)
600
500
400
300
200
100
0
85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05
year
via port
via MPT



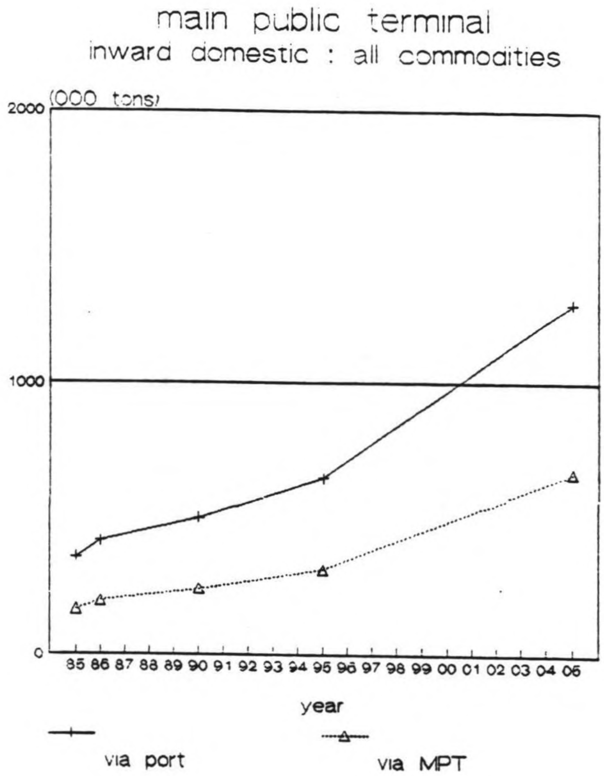
main public terminal
outward domestic : sugar
(000 tons)
20
10
0
85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05
year
via port
via MPT

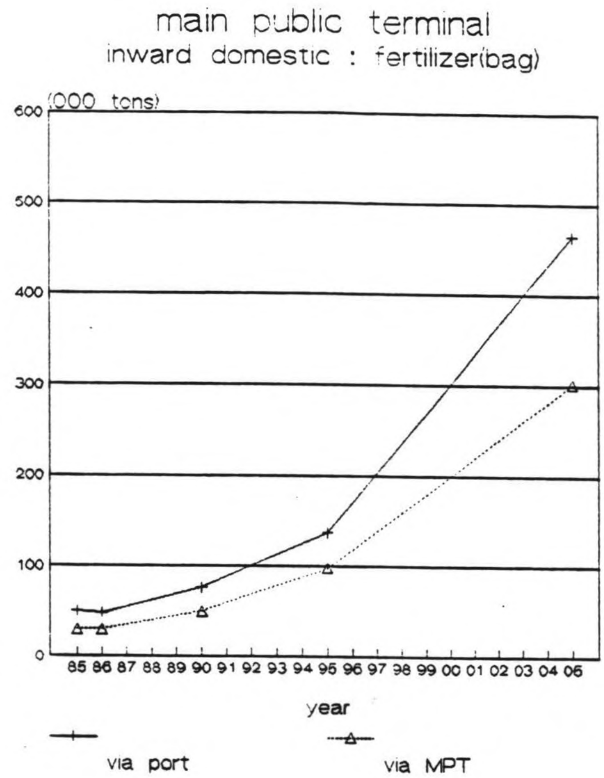


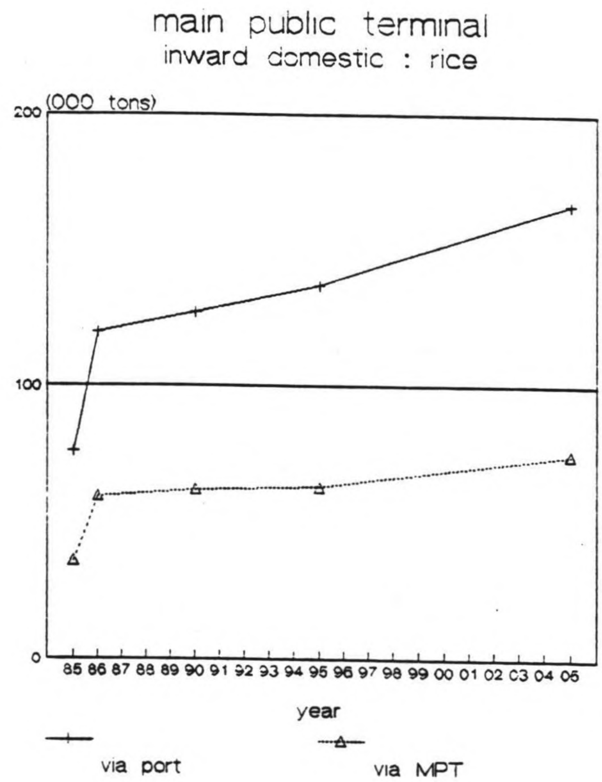
main public terminal
outward domestic : chemical
(000 tons)
20
10
0
85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05
year
via port
via MPT

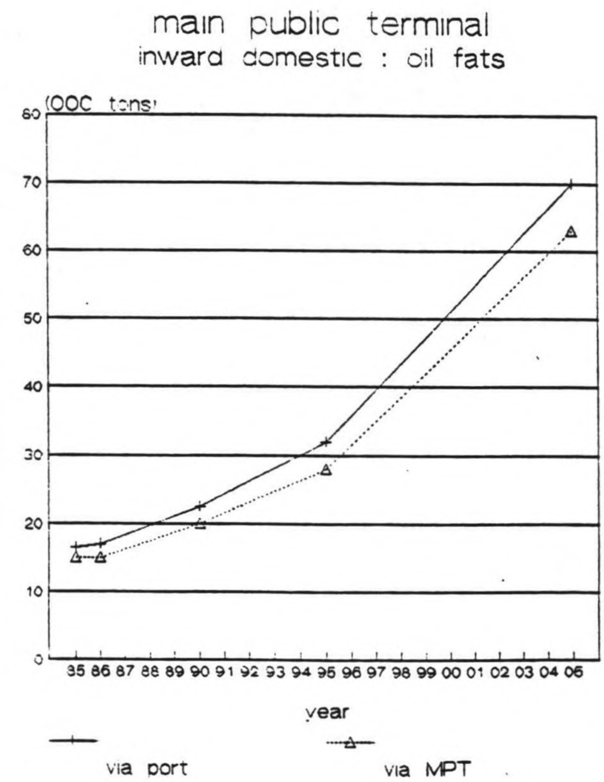


main public terminal
outward domestic : oil fats
(000 tons)
50
40
30
20
10
0
85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05
year
via port
via MPT


main public terminal
inward domestic : all commodities
(000 tons)
2000
1000
0
85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05
year
via port
via MPT


main public terminal
inward domestic : fertilizer(bag)
(000 tons)
600
500
400
300
200
100
0
85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05
year
via port
via MPT


main public terminal
inward domestic : rice
(000 tons)
200
100
0
85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05
year
via port
via MPT


main public terminal
inward domestic : oil fats
(000 tons)
80
70
60
50
40
30
20
10
0
85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05
year
via port
via MPT

chapter III
TERMINAL FACILITIES REQUIREMENT CALCULATION

chapter III
TERMINAL FACILITIES REQUIREMENT CALCULATION

3.1 General

For optimatization of berthing facilities, new as well as extention of an existing facilities, there are three methods of solution that can be applied: (I) empirical rule of thumb, which is only suitable for simple systems with low traffic intensity, (II) queueing theory, which is still acceptable for simple systems with high traffic intensity, and (III) simulation model technique which is the only appropiate method for complex systems if sufficient data is available [4].

The general rule for choosing the method, as far as the result is still within acceptable acuracy, is that the more simple method should be applied. Most of port operational system, however, fall under the category of complex system. In these cases the queueing theory does not adequately give the reliable result. Therefore, the simulation model technique becomes the inevitable choice. This situation applies to the Main Public Terminal as well, because of the following reasons:

(I) priority berthing rule for one type of vessel (shuttle ship) over other types of vessel for international quay, although this ship has no right to berth along domestic quay. Moreover, preference of ships carrying international cargo for the international quay and preference of ships carrying domestic cargo for the domestic quay, make the berth allocation rule more complicated. Obviously, this situation is different with the "first come, first served" berthing rule of queueing theory.

(II) The above situation implies also that all arriving ships cannot be acommodated at all berths, which are not in agreement with the queueing theory basis.

(III) the quay length concept was choosen instead of the berth number concept of queueing theory, based on the investigation result of Hansen (1972) that the first concept was proven to give a considerably less quay length than the second [3].

Besides one advantage proven by Hansen above, the simulation technique has several other advantages over the queueing theory, such as:

(I) Technical approach of simulation technique is both predictive and optimizing. Whereas the queueing theory's is only predictive [3].

(II) The applicable area of simulation technique is wider, thus in the case of port planning, the more parts of the port facility can be investigated. Moreover, it has been proven, that various results can never be obtained without applying simulation technique [4].

(III) The simulation technique permits the use of real statistical behaviour of the system, therefore even in simple port problems, this method is used mainly to improve the realism.

(IV) The simulation technique is also the best tool to increase understanding about the system itself.

But, the simulation technique is not free from some drawbacks. This is mainly because of large data analysis requirements and a large number of repetitive calculations. The simulation technique becomes powerful tool only if it is assisted by computer. Although, today most personal computers are sufficiently powerful for assisting this method, the severe problem is regarding the availability of the needed software and/or programming. Besides the lack of data, in most cases, the reason which restricts the application of this method is therefore due to its time and cost consuming reason. On the other hand, if a port simulation model has been set up, it can be utilized for other ports. For ports which are similar, either physical or operational, in the system, only slight modification is needed. Thus, especially in port planning, this will minimize the above restriction.

With regard to computer programming, a computer programming language should be determined first before developing a computer simulation model. There is wide choice as to what language can be used, that is, ranging from general purpose computer languages, such as: Fortran, P/L 1, etc.; to various special purpose simulation languages, such as: GPSS, Simula, Simcript II.5, and Prosim. The choice should be based upon the availability of the software, simulation analyst and programmer. For this study, it is a great advantage that the simulation model can be developed using the so-called Personal Prosim software, prepared by Sierenberg en de Gans in 1986. The applicable language for this software is Prosim, the most recent special purpose, user oriented, simulation language, developed by Delft Technology of University, and updated and supported by Sierenberg en de Gans.

The main features of this software are: (I) it is destined for use on personal computers, (II) modular programming, where individual module can be modified with slight reference to other modules, (III) it provides generation of random numbers sampled from several statistical distribution, and (IV) discrete as well as continous values can be handled, thus it offers even a combined discrete and continous simulation [12].

Having recognized the effectiveness of the computer simulation technique, the investigation of Main Public Terminal using this method can be expected to give the following outputs:

(I) the composition of total time spent by ships in port (porttime)
(II) the relationship between port time (or ship-cost in port) and various planning strategies (berth length, working system etc.)
(III) the daily amount of cargo stored in the shed or in the yard during the simulation time
(IV) the information needed for cargo handling equipment calculation.

3.2 Modelling Process

Simulation is the process of designing of a real system and conduction experiments with this model for the purpose either of understanding the behaviour of the system or of evaluating various strategies (within the limits imposed by a criterion or set of criteria) for the operation of the system [Shannon][10]. Starting from this definition, a development process for a computer simulation modelling on port operational system of Main Public Terminal, requires the following successive stages: (I) understanding the system being studied, (II) programming, (III) validation (and or calibration), and (IV) experimentation.

The term systems means a group of units (components) which operate in some interrelated manner [11].
According to L. Jones (1972), that a system consists not only of the specified components, but also the interest in viewing the system. This is because, with a different view, the same set of units may lead to different systems [9].
Port operational system can be described as an administration of port facilities (space and equipment) and organisation of port labour, in order to fulfill the function of port as a transfer terminal in the total chain of transport, where goods (and some time passanger) being tranfered from sea to land and vise versa. The handling of goods in this tranfer point will include: loading/discharging, routing/moving, storing/warehousing, and receiving/delivery of cargo.
The cargo handling operation in the general cargo terminal such as Main Public Terminal, is not simple, mainly due to the so wide variety of packaging form of general cargo, ranging from unitized cargo: container, pallet, preslung; to non-unitized cargo/breakbulk: cases, carton, loose drum, and sometime heavy lift.
Using terminology introduced by R.L. Ackhoff (1972), the port operational system of Main Public Terminal, has the following features [9]:
(I) as a common user terminals, the goal of this system is to handle cargo flow through the terminal in an economical manner
(II) concrete, which means that this system contains some physical components

(III) open, because this system interacts with external elements
(IV) dynamic, because its state changes over time.
Furthermore, this system comprises a number of components such as: ship, quay, shed, yard, equipment, port administration, cargo and other smaller entities.
In addition to those explanation, the interest of port administration as a main investor of port facilities, in viewing this system, is in the performance and cost of its physical activity.

After having sufficient understanding of the actual system, the first step in the programming is to schematize the system by leaving out all non-relevant aspects. Schematization is a matter of simplification. This consists of four major principles:
(I) deletion of component, attributes (any value components; which has no significant effect on the expected output/result.
(II) the use of random variables to avoid the description of rather complicated activaties.
(III) reduction of the value range of attributes to avoid complicated and expensive calculations.
(IV) aggregation by replacing a number of components/attributes by one (representative) component/attribute.
The decision concerning the degree of schematization is very important. It must be based upon, not only the availability of data, but more importantly is the objective of utilizing the simulation method. In other words, it refers to the outputs expected. In this study, these outputs have been mentioned in previous subchapter.
Moreover, because of long-term planning, the main features of the model for Main Public Terminal was rather high schematization. These include:
(I) The terminal layout has been simplified. It was divided into two sub-terminals, namely: a) international sub-terminal, for international cargo and b) domestic sub-terminal, for domestic cargo.
Each subterminal is served by separate sheds, yards and equipment. Furthermore, smaller entities, such as: forklifts, trucks, barges and other smaller cargo handling equipment have been omitted.
(II) The port administration is actually an aggregation of harbour-master, terminal owner, port labour and other institutions involved in the cargo handling operation.
(III) With regard to loading/discharging operations, the quantity of cargo on ship's board changes discretely every hour as a result of the loading/discharge productivity. The amount of hourly loading/discharging productivity depends on the number of cranes in use, packaging form of cargo, and type of ship. This aggregation solution was taken in order to avoid

complication if the cargo is handled unit by unit with various packaging forms and various cargo handling rates. The similar solution was also taken for receiving/delivery of cargo in the shed and in the yard.

(IV) The arrival of outbound cargo in the storage facilities was merely some specified time span (approximately: dwelltime) before arrival of the corresponding ship. This manipulation may be acceptable, considering that the outbound cargo will often be brought to the terminal once the arrival time of the expected ship is known. Moreover, in the Main Public Terminal case, the average of dwelltime of outbound cargo in the storage facilities was relatively short, less than a week.

However, the schematization has to be carried out carefully, in order to keep the model still meaningful. Due to the fourth simplification above, the model will lose its capability to investigate the contribution of cargo delay to the port time of ship. Such simplification, however, was still used because it offers much simpler solution. After all, schematization is an art in modelling; there is always compromise between easy preparation on one side, and great detailed results on other side. Sometimes, the availability of data should be taken into consideration as well.

The second step in the programming is to develop a verbal model, which describes the activity of components and their relationship. A further step is the translation of verbal model into a computer simulation program. This program should be verified in order to prove whether the model has been properly programmed. It is one of the advantage of using the Personal Prosim software in this modelling, because it offers verification facilities.

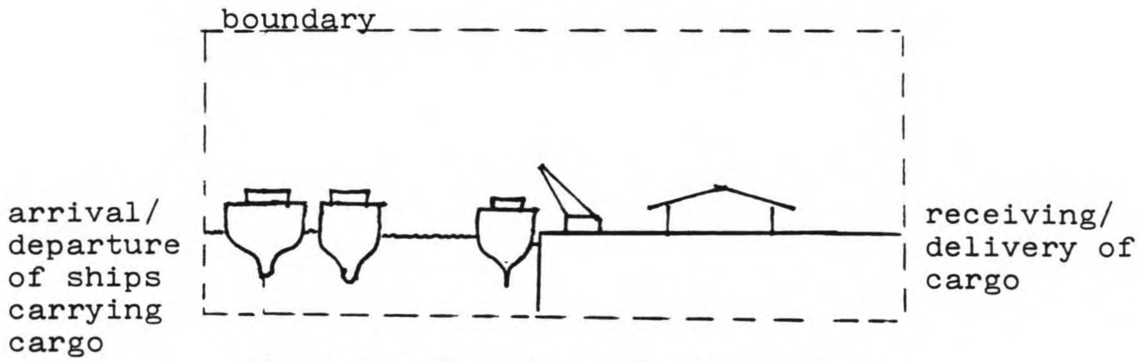
The objective of the validation stage is to ensure whether the simulation program is a proper representation of the system being studied. Therefore, this is a very important part of simulation modelling. But the difficulty arises, however, because the model is never a complete representation of the real system, whereas the real system is never completely known. Therefore, it must be recognized that the objective of proving the simulation correct can only be approached, not achieved [11]. Nevertheless, the validation process has to be carried out so as to have a model which represents the real system adequately for the purposes of the study for which it is used. Thus, a model is considered valid if it gives a valid result. In other words, the difference between model generated data and data obtained from a real system is still within acceptable limits. For this purpose, some data should be collected to be used to test the model validity. The result of validity testing will be presented in the next sub-chapter.

Finally, the most important stage in the simulation modelling is to perform experimentation of the model in order to obtain outputs to which the simulation modelling is trying to achieve. These outputs are often information of possible future situations. The results from experimentation and their analysis will be given in the next sub-chapter.

3.3 MPTSIM Model

3.3.1 Boundary

According to Banks and Carson II [1], a system is often affected by changes occuring outside the system or in the system environment. Thus to model a system, it is necessary to decide on the boundary between the system and its environment. Based on the purpose of this study, the port operational system of MPT and also its model which was named MPTSIM model, can be represented:



figre 1.a Boundary of MPT system.

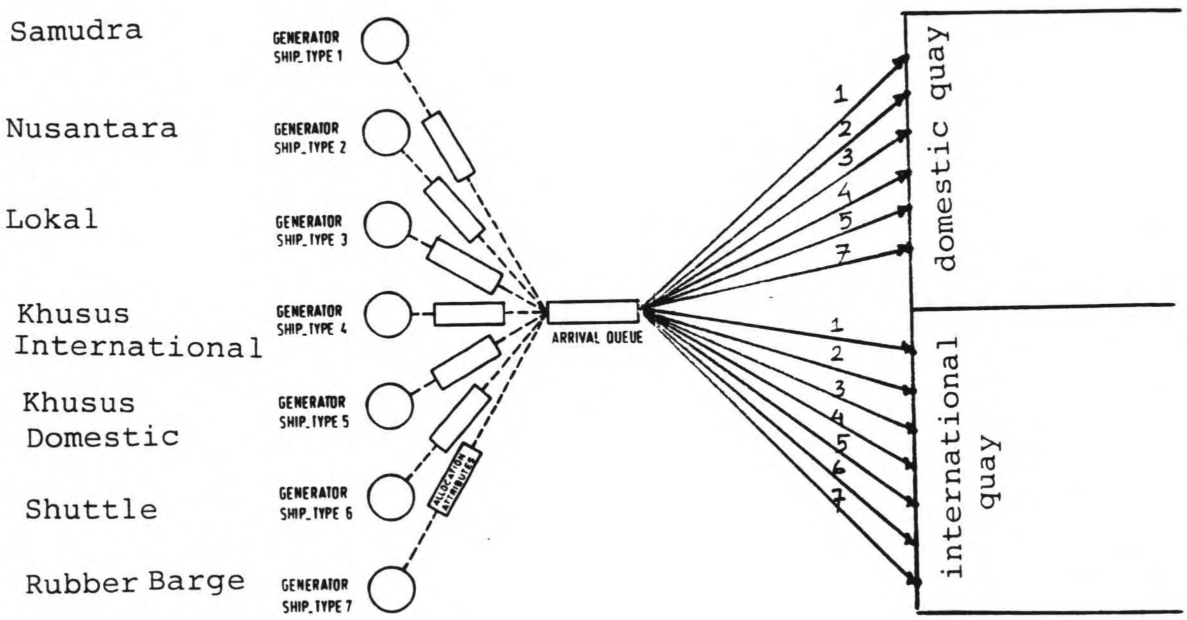
At the boundaries of our knowledge of a system we tend to use random variables [ ]. This is because it needs exhaustive study to predict exactly, for instance, the arrival of ship, and moreover it would mean greatly widening the boundaries of the sytem. Therefore it is simply to study past records, observe the distribution, and then sample from it. Moreover, using Personal Prosim which has a random generation facility, it is no need of findings out exactly how the arrivals are generated.

The water-side boundary of the MPTSIM model is the arrival/departure of ships carrying cargo. The arrival time of ships are stockastically determined following the specified distribution pattern. The departure of ships take place after the completion of berthing activity. The amount of cargo to be carried is randomly determined based on a certain distribution. For other attributes of ship, only a few are stockastic and most of them are deterministic values.

The land-side boundary of the MPTSIM model is the receiving/delivery of cargo by inland transport. The time of receiving/delivery is determined based on two randomly defined values: arrival of corresponding ship and dwell time of cargo in storage. The amount of cargo to be received/delivered is also determined based on the corresponding shipload which is stockastically defined as well. However, the assumption is made for the receiving/delivery rate.

3.3.2 Configuration

The general configuration of the MPTSIM model with regard to ship process:



1. Queue structure and Management

Every arriving ship joins a single "waiting" queue. This schip is placed according to its arrival time. The assignment of ships to berth room is attempted after every arrival and after each departure. The considered ship is the first ship with highest priority. The queue management regarding the allocation of berth room is that the berthing of the considered ship will be attempted, and if it cannot be accomodated because the berth space is not available, no other ship will be considered. In other words, such strict rule is maintained, even though there may be smaller, lower priority ships waiting. These will not be permitted to berth until the ship being considered has been serviced. After each assignment of a ship to a berth, the remaining berth length is checked and further assignments are attempted using the same allocation rule. It can happen that ship does not spend time in the waiting queue, if the required berth space is available when it arrives.

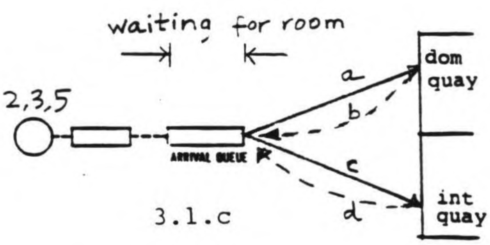
2. Berthing

Several conditions must be met before a ship can be berthed:
1. Enough quay length must be available and designated to that ship.
2. At least one crane (either ship crane or quay crane) must be available for (un)loading operation. Thus when a ship has no ship's crane and no quay crane is available (all quay cranes are busy), that ship will not be allowed to take up berth space.

The berthing allocation rule:

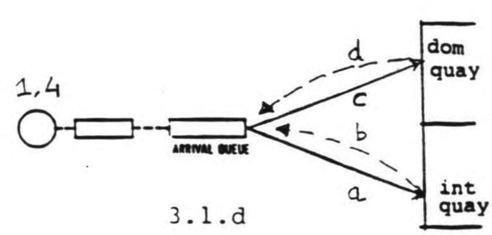
No	Ship	cargo	Quay		Priority for int. quay	Preference		Crane		see fig.
			int.	dom.		int. quay	dom. quay	Ship	Quay	
1	Nusantara (2) Lokal (3) Khusus (5)	domestic	+	+	-	-	+	+	-	3.1.c
2	Samudra (1) Khusus Int. (4)	int.	+	+	-	+	-	+	-	3.1.d
3	Rbarge (7)	int.	+	+	-	+	-	-	+	3.1.e
4	Shuttle	int.	+	-	+	-	-	+	-	3.1.f

Room in domestic quay (a)?
If yes: mooring there.
If no: b.
Room in international quay (c)?
If yes: mooring there.
If no: remains in the queue (d).



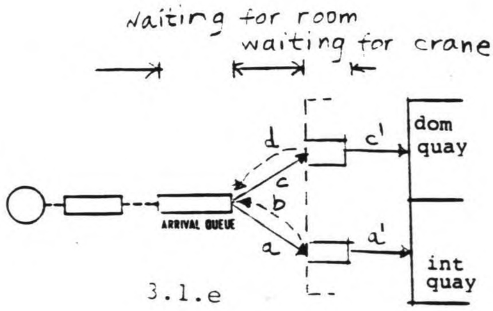
3.1.c

Room in international quay (a)?
If yes: mooring there.
If no: b.
Room in domestic quay (c)?
If yes: mooring there.
If no: remains in the queue (d)



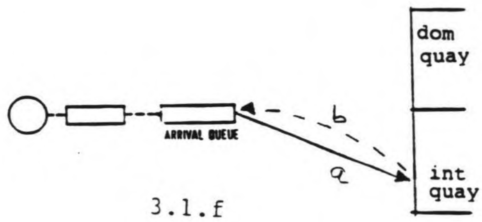
3.1.d

a, b, c, d: similar Samudra and Khusus Int. ships.
For R-barge, mooring is permitted only after room and quay crane are available.



3.1.e

Room in international quay (a)?
If yes: mooring there
If no (b):
- asks Port Administration to order a number of non-shuttle ships in international quay to vacate/leave until room available for her.
- If room is not available: shuttle remains in queue.



3.1.f

3. Quay Crane Allocation

The quay cranes are distributed among the requiring ships according to their "arrival" time in the CRANESHIPSET (a set of ships which require quay crane). The number of quay cranes assigned to a ship is the smallest of either the number of quay cranes available or the number of quay cranes the ship needs.

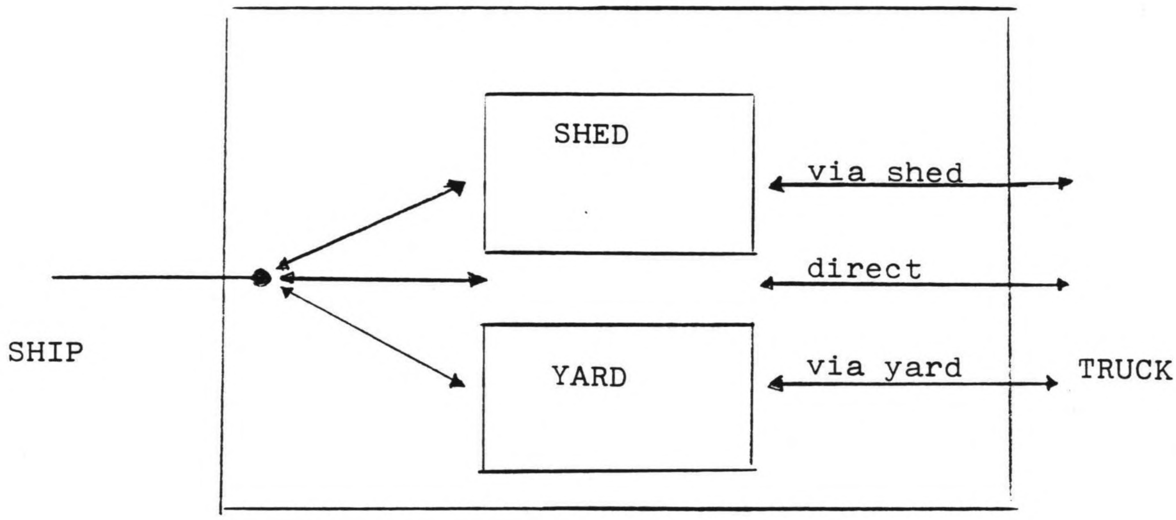
4. Ship Servicing Method

The loading/discharging time depends on:
- amount of cargo to be handled
- cargo handling rate, which is dependent on the packaging form of cargo
- number of crane (shipcranes and quay crane) employed

whereas the berthing time, the period of time spent by a ship along the berth, depends on several factors:
- loading and discharging time
- mooring and unmooring time
- working situation: working time and production level of cargo handling operation.

With regard to cargo movement in terminal, the MPTSIM model has the following configuration:

figure 1.g



	routing of discharged/ loaded cargo	receiving/ delivery of of cargo
amount: time	randomly defined during discharging/ loading operation of ships	randomly defined estimated based on departure of ships and dwell time of cargo in storage.
rate	cargo handling rate multiplied by routing ratio	assumed: 12 tons/ hour for delivery and 24 tons/hour for receiving

3.3.3 Structure

The computer simulation program for Main Public Terminal was named MPTSIM. This model consists of two parts:

(I) definition section, which shows the configuration of the model and

(II) dynamic section, which shows the dynamic behaviour of the living components.

The structure of this model is represented in figure 3.1.

The definition section corresponds to only one module, namely Define Module. Whereas the dynamic section can contain as many modules as are necessary. The dynamic section of this model consists of 6 (six) modules, namely:

(I) Main Module, which describes a process description of system single component Main. This module deals with a number of technical matters not directly related to the model, such as: simulation schedulling, receiving of input, and providing output.

(II) Generator Module, which describes a process description of user defined class component Generator.

(III) Ship Module, which deals with a process description of user defined class component Ship.

(IV) Storage Module, which takes care of a process description of user defined class component Cargo.

(V) Port-Administration Module, which describes a process description of user defined single component Port-Administration, and

(VI) Surveyor Module, which takes care of a process description of user defined single component Surveyor.

A number of macros (or subroutines) is also attached to this model, that is:

(I) Cargo-Sender Macro, which takes care of the creation of outbound cargo.

(II) Cargo Receiver Macro, which deals with the creation of inbound cargo, and

(III) Crane Planner Macro, which deals with the crane allocation to the requiring ship.

3.3.4 Process Description

There are two sorts of components which constitute the MPTSIM model, that is:

(I) data component, which is "dead" during the simulation time (its function being to carry information) and

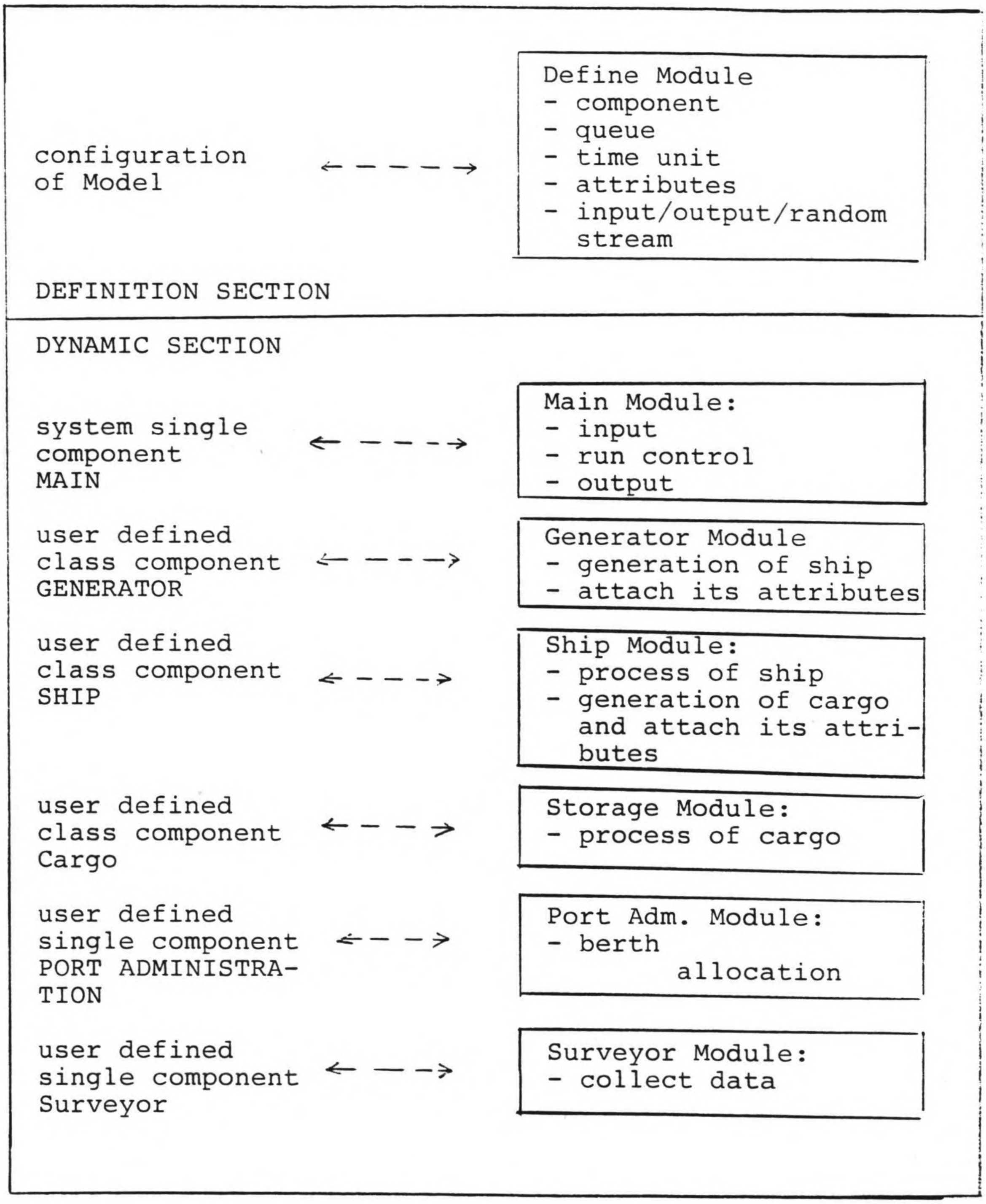
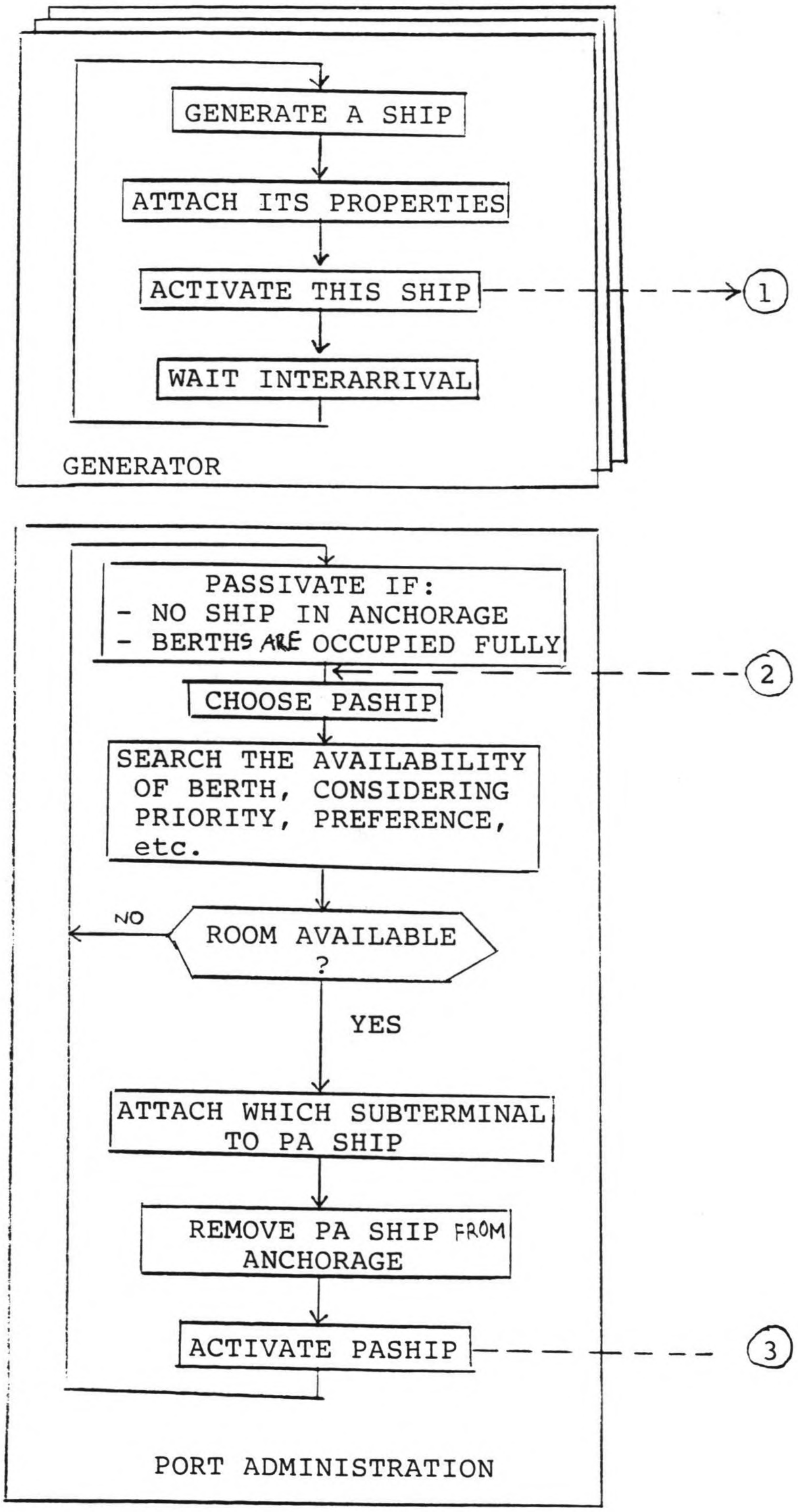
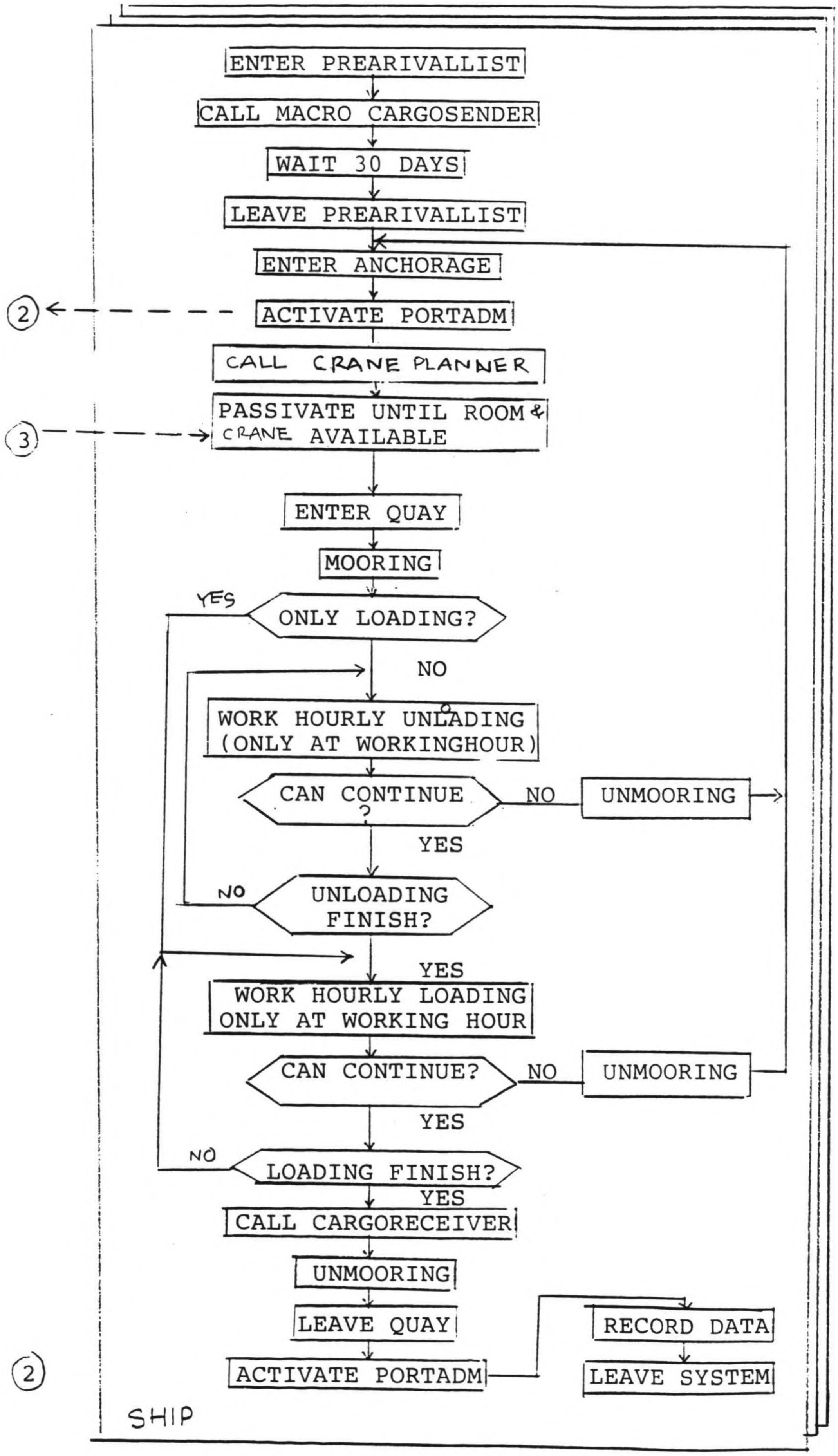
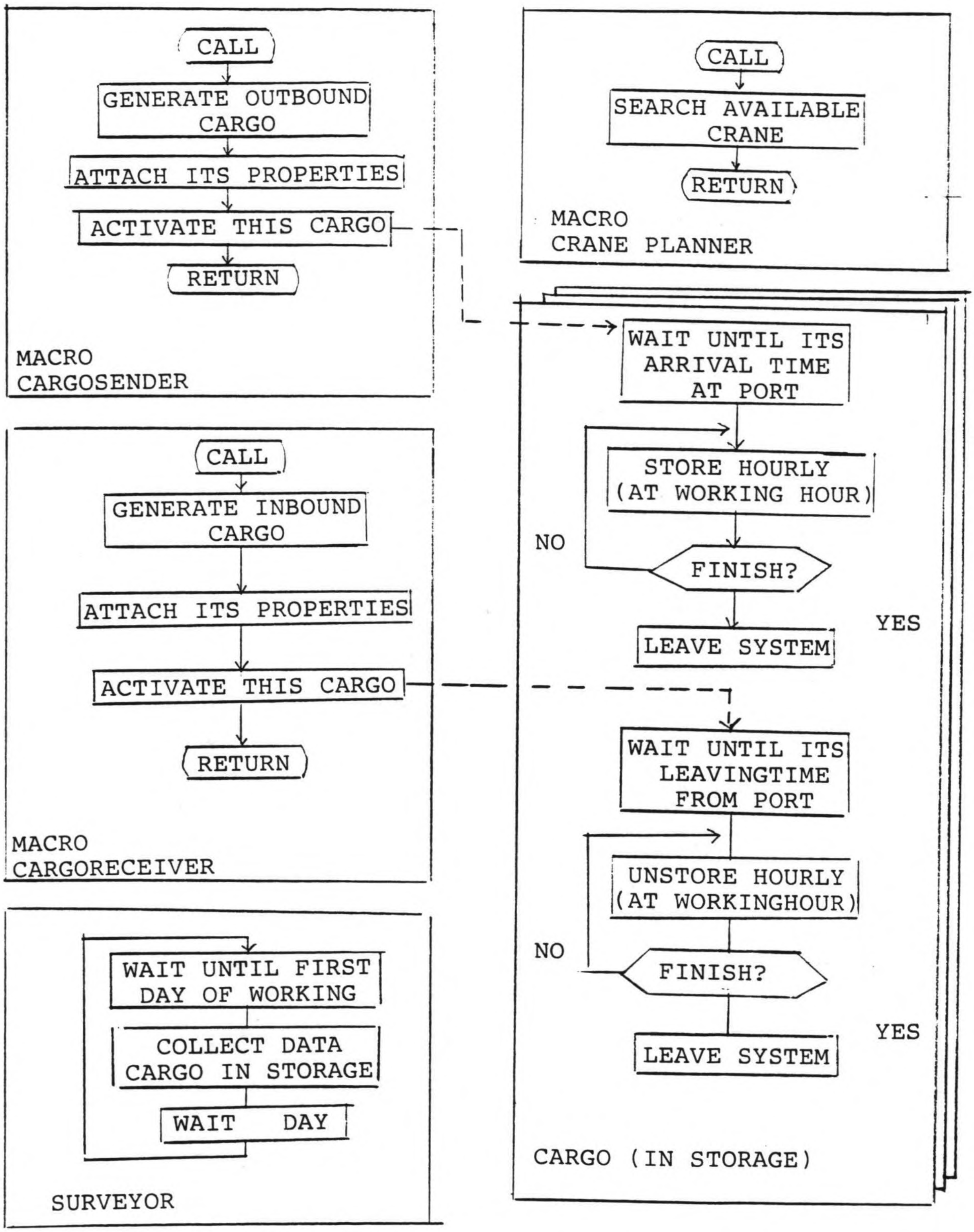


figure 3.1. Structure of the MPTSIM Model

figure 3.2. Flowchart of the MPTSIM program




ENTER PREARIVALLIST
CALL MACRO CARGOSENDER
WAIT 30 DAYS
LEAVE PREARIVALLIST
ENTER ANCHORAGE
2
ACTIVATE PORTADM
CALL CRANE PLANNER
3
PASSIVATE UNTIL ROOM & CRANE AVAILABLE
ENTER QUAY
MOORING
YES
ONLY LOADING?
NO
WORK HOURLY UNLOADING (ONLY AT WORKINGHOUR)
CAN CONTINUE ?
NO
UNMOORING
YES
NO
UNLOADING FINISH?
YES
WORK HOURLY LOADING ONLY AT WORKING HOUR
CAN CONTINUE?
NO
UNMOORING
YES
NO
LOADING FINISH?
YES
CALL CARGORECEIVER
UNMOORING
LEAVE QUAY
RECORD DATA
2
ACTIVATE PORTADM
LEAVE SYSTEM
SHIP


CALL
GENERATE OUTBOUND CARGO
ATTACH ITS PROPERTIES
ACTIVATE THIS CARGO
RETURN
MACRO CARGOSENDER
CALL
SEARCH AVAILABLE CRANE
RETURN
MACRO CRANE PLANNER
CALL
GENERATE INBOUND CARGO
ATTACH ITS PROPERTIES
ACTIVATE THIS CARGO
RETURN
MACRO CARGORECEIVER
WAIT UNTIL ITS ARRIVAL TIME AT PORT
STORE HOURLY (AT WORKING HOUR)
NO
FINISH?
YES
LEAVE SYSTEM
WAIT UNTIL ITS LEAVINGTIME FROM PORT
UNSTORE HOURLY (AT WORKINGHOUR)
NO
FINISH?
YES
LEAVE SYSTEM
CARGO (IN STORAGE)
WAIT UNTIL FIRST DAY OF WORKING
COLLECT DATA CARGO IN STORAGE
WAIT DAY
SURVEYOR

(II) living component, which is "alive" during the simulation time, and therefore performs a certain activity that may change the value of the component itself or the value of the other components.

In the MPTSIM model, the components which fall into first category are: quay, crane, shed, and yard. Whereas the components which belong to the second group are: Main, Generator, Ship, Cargo, Port Administration and Surveyor.

The dynamic behaviour of the model will be sufficiently represented by sets of process description of those living components. The flowchart which outlines the process description of those living components (excluding Main component) and their relationship, are presented in the figure 3.2. Nevertheless, a more detailed description of user defined living components are given below.

(I) Generator

The MPTSIM model is capable of handling any number of generators at one time. In this study, 7 (seven) generators have been set up in order to create 7 (seven) corresponding types of vessel, namely: Shuttle, Samudra, Khusus International, Nusantara, Lokal, Khusus Domestic, and Rubber Barge. After the creation of a corresponding ship, the generator assigns a number of attributes to that ship, such as: type, trade, priority, length, cargo, ship's crane, required quay crane, cargo handling rate, packaging form of cargo, working hour per day, ship's cost per hour in port, mooring time, unmooring time, etc. Some of these values are stochastically defined. Different statistical distribution may be used for different type of vessel. After the assignment of these attributes, the ship is activated so as to perform its own process in the Ship Module. Before generating the next ship, the generator waits for a certain length of time specified according to the inter-arrival time distribution of that ship.

(II) Ship

After the activation by the generator, the ship enters the prearrival list (as a queue activity), and stays there for 30 days. This manipulation was made merely in order to have enough time for the outbound cargo, which should be stored in the shed and in the yard for a certain length of time (approximately dwelltime, randomly defined) before being loaded to the corresponding ship. Therefore, having just entered the prearrival list, the ship creates two sorts of outbound cargo: a) that which will be stored in the shed, and b) which will be stored in the yard. Afterward, a number of attributes is assigned to those two cargoes, such as: amount,

trade, routing (indicate the specified storage facilities), and its arrival time to the storage facilities. Finally, these cargoes are activated so as to start their own "life" in the Storage Module.
Having spent 30 days on the list, the ship arrives in port, and enters the waiting row (as a queue activity), and requests the Port Administration for berthing room.
If at this time, the Port Administration is in passive condition, it will automatically be reactivated by this request. While waiting the answer, the ship becomes passive. If there is enough berthing room, the ship (that is the first ship in waiting row with highest priority, not necessarily the ship which deliver request at this time) will be reactivated by the Port Administration. Meanwhile the other ships in waiting row remain passive. For the active ship requires quay crane, it registers itself in Craneshipset and asks the required quay-cranes from craneplanner. This ship becomes passive if there is no crane (ship's crane or quaycrane) and waits until it gets at least one crane in the next reallocation of quay cranes. This reallocation takes place every 'arrival' and 'departure' of ship in Craneshipset. The ship departs from this set, only if the (un)loading operation has been finished or has to be stopped. Having berthing room and at least one crane, the ship is able to continue her own life (process), such as: mooring, unloading, loading and unmooring. Mooring and unmooring time are 2 hours respectively. Whereas (un)loading time depend on several factors, such as: the amount of cargo to be (un)loaded, the cargo handling rate, the total number of cranes used (ship's or quay crane), (the quay cranes are obtained from craneplanner macro), the effective working, and the daily working hour. The last factor implies that the cargo handling operation takes place only during working hour. For this purpose, every hour during working hours, the ship will check the time. If the time exceeds the working hour, the ship stops the operation, and continues next day.
It is necessarily known, that upon arrival of shuttle ship (deserves priority over international quay), if there is not enough berthing room for her, one or more non-shuttle ship (if any) on an international quay must stop the cargo handling operation and vacate the quay, in order to give space for arriving shuttle ship. After unmooring, this ship reenters the waiting row with higher priority than later arriving non-shuttle ships. For craneshipset member, just having finished loading operation, it returns the quaycrane it uses during loading operation and quits from this set. And having performed the mooring activity, the ship will create two sorts of inbound cargoes: a) that which will be stored in the shed and b) that which will be stored in the yard. The similar attributes of outbound cargo, are also assigned to these cargoes. Afterward, they are activated so as to start their process in the Storage Module.

Finally, the ship leaves the port, informs this to the Port Administration, and disappears from the system.
It may be valuable information that: a) the navigational operation (tide, tug, and pilot factors) are beyond this MPTSIM model. Furthermore, the mooring and unmooring activity as a part of ship operation can always be performed at due time; b) after the creation of cargo by ship, there is no interactional life between the cargo in storage module and the corresponding ship in ship module.

(III) Cargo

The process description of outbound and inbound cargo are similar. After activation by the ship, the cargo waits for a certain time until its arrival time at port (outbound cargo) or until its leaving time from port (inbound cargo). Having performed the storing activity for outbound cargo, and the unstoring activity for inbound cargo; they disappear from the system. There are three main cargo flows concerning their trade and packaging form, that is:
a) container (international cargo)
b) non-container of international cargo
c) non-container of domestic cargo.

(IV) Port Administration

Although cargo handling only takes place during working hours, Port Administration works 24 hours a day, and 7 days a week, which means that other operations such as mooring and unmooring may take place beyond working hours. And it becomes passive ("relax") if there is no ship in the waiting row. The PASHIP which is under consideration of Port Administration, is the first ship in the waiting row with highest priority. The berthing allocation depends on the type of vessel. The shuttle ship will only be given berthing room on the international quay with (highest) priority over other types of vessel. The ship carrying international cargo (other than shuttle ships) will have preference over the international quay. This means the Port Administration will seek berthing room on the international quay first. If this is not available, the Port Administration attemps to seek a possibility on the domestic quay. Similar preference applies also for ships carrying domestic cargo for domestic quay. As mentioned earlier, upon the arrival of shuttle ship, it may happen that some of the non-shuttle ship on the international quay must vacate the berth. These ships are chosen, according to the criterion "the last ship arrived on the quay with lowest priority", until there is enough berthing room available for arriving shuttle ship. Therefore, the shuttle ship will only stay in the waiting row during the unmooring

of vacating ship takes place. Or if the other shuttle ships occupy the international quay without giving enough berthing room for arriving shuttle ship. In summary, there two attributes given to the ship by Port Administration, that is:
a) subterminal (international or domestic), and
b) cargohandling (stop or not).

(V) Surveyor

The process description of this component is very simple. At the beginning of each working day, a certain amount of data is recorded, that is:
a) container international cargo in the shed and in the yard
b) non-container international cargo in the shed and in the yard
c) non-container domestic cargo in the shed and in the yard.

3.3.5 Inputs

As mentioned earlier, the result of traffic forecasting is one of several inputs to be supplied to the model. Other inputs are: terminal facilities information, inter-arrival pattern of each type of vessel, ship's cargo information, ship's length, cargo handling rate for each ship's type and packaging form of ship's cargo, distribution information concerning ship's cargo over storage facilities, cargo residence time (dwelltime) of cargo in the storage facilities, number of ship's crane and the required additional quay cranes, and ship's cost per hour in port. Detailed information of these data can be found in Annex B. However, brief descriptions given below:

(I) Terminal Facilities Information

This information incorporates at least: international quay length, domestic quay length and the number of mobile quey cranes. As practiced now, the 10 meters overhanging on free end of the quay will be employed, thus making the available quay length 10 meters longer than its actual physical length for either international or domestic quay. Furthermore, the interspacing between ships of 5 m as practice now will be employed for 1986. However an interspacing of 10 percent of LOA is considered for the future.

(II) Interarrival pattern of ships

The interarrival pattern of Samudra, Nusantara, Khusus and Lokal vessels follow the Negative Exponential

Distribution (NED) which is based upon the findings of a consultant. It is assumed that such distribution will also apply to rubber-barges, the arrival of which in port is (considered) less scheduled and independent from the seasonal (rainy/dry) effects. This is different for shuttle vessels, which have a more fixed scheduled arrival. Therefore, the Erlang distribution with a high value of k is assumed for these vessels. The Personal Prosim suggested, however, that an Erlang distribution k> 10 should be replaced with Normal distribution.

(III) Distribution of Ship's Length

The average and histogram of length of Samudra, Nusantara, Lokal, and Khusus have been investigated and presented in Annex B2. Furthermore, it was assumed that Shuttle and Rubber barge follow the uniform distribution.

(IV) Cargo of Ship

The average value of ship's cargo per call of Samudra, Nusantara, Lokal and Khusus is available. However, its distribution was not found. In this study, the amount of cargo allocated to a ship is determined based on several factors, that is: average ship's cargo, economically minimum cargo, possible maximum cargo, and ship's length. Such allocation distributions are the refore dependent to the ship's length (see Annex B2). Furthermore, the cargo allocation distributions of Shuttle and Rubber barge are assumed to be independent to their length and to follow an uniform distribution.

(V) Cargo Handling Information

Cargo handling rates were determined in Annex B3. These rates are given according to the type of ship and the packaging form of cargo (in tons per crane hour).

Based on the past data, the average ship's crane employed for cargo handling operation of Samudra, Nusantara, Lokal and Nusantara have been also determined. An average of two ship's cranes is employed by Samudra and Nusantara. Whereas an average of one ship's crane is used for Lokal and an average of three ship's cranes is used for Khusus. Mobile quay cranes are mainly needed for assisting the smaller ships in cargo handling in case of ship's crane breakdowns. And these quay cranes are also used for heavy unit load handling. Because of no data regarding the utilization of these cranes, in the simulation, therefore the cargo handling is carried out by ship's crane for 4 (four) types of ship mentioned above. This consideration applies also to the shuttle ships, to which an average of two ship's cranes is assumed [7]. However, because there is no crane aboard, one mobile quay crane is necessary for cargo handling operation of rubber barge.

(VI) Routing and storing of cargo

The information regarding the routing of cargo to the shed of yard and the residence (dwell)time in those storage facilities have been investigated in Annex B2. The cargoes are distinguished into three categories: container (of international cargo), non-container of international cargo and non-container of domestic cargo.

(V) Ship's Cost

With regard to ship's cost in port, the equation of ship's cost per hour in port as a function of ship's length (LOA) has been derived based on the consultant analysis (see Annex C3).

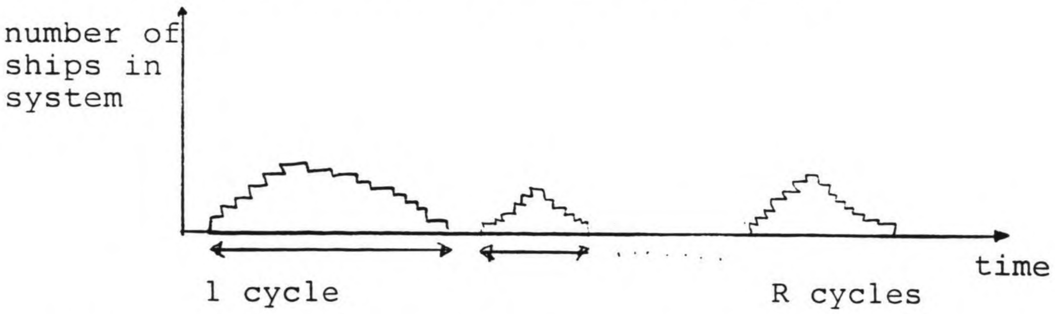
3.3.6 Simulation Time

Since the model is an input - output transformation, and since some of the input are random variables, therefore in general, the output are random variables as well. In other words the model variables are mostly stochastic or probabilistic in nature [1]. Moreover, according to this nature, and the outputs to be collected, the MPTSIM simulation can be considered as a steady-state simulation, whose objective is to study long-run, or steady state behaviour of a non terminating system. A non-terminating system is a system that runs continuously, or at least over a very long period of time [1].

However, statistical sampling procedure assume that experimental output data are in the form of a collection of distinct and statistically independent random observation [9]. To meet this requirement, there are three methods of simulation run:

(1) Regenerative Method.
Simulation run can be divided into a series of cycles. The behaviour of the system during different cycles are both statistically independent and identically distributed. The cycle begins at the regeneration point, i.e. at the point where the system again enter a certain special state from which the simulation can proceed without any knowledge of its past history. In MPTSIM model, this point of time is the time when there is no ship in the system. The cycle ends when the system again reaches the regeneration point (when the next cycle

begins). Thus the length of a cycle is just the elapsed time between consecutive occurences of the regeneration points. This is illustrated in figure below:



In order to find out the length of a cycle, a series of runs performed gives the following result: (see figure 3.3 a)

Year	Simulation Time (years)	Number of cycle	Average length of of one cyle (years)
1986	2	5	0.4
1990	5	8	0.6
2005	5	-	> 5

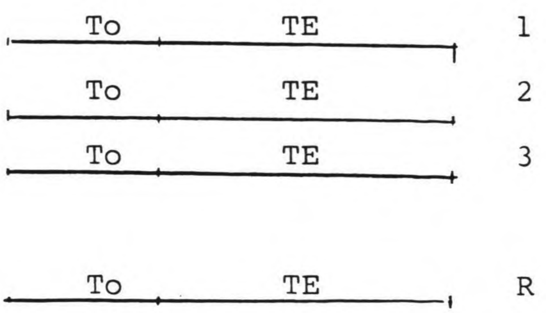
It turned out that the average cycle period is too long, thus is not applicable.

(2) Repeated Runs Method.
Execution of a series of completely separate and independent simulation runs of equal length but different seed of random number. Different with Regenerative method above, the simulation time consists of two phases:

(I) initialization phase, from time o, under initial condition, to time To. The determination of To is important, because at this time, the system state should be more representative of steady behaviour than the original initial condition.

(II) data collection phase, from time To to the stopping time To + TE, thus represents a specified period of time of TE. The length of TE should be long enough to guarantee sufficiently precise estimates of steady-state behaviour.

This method is illustrated below:



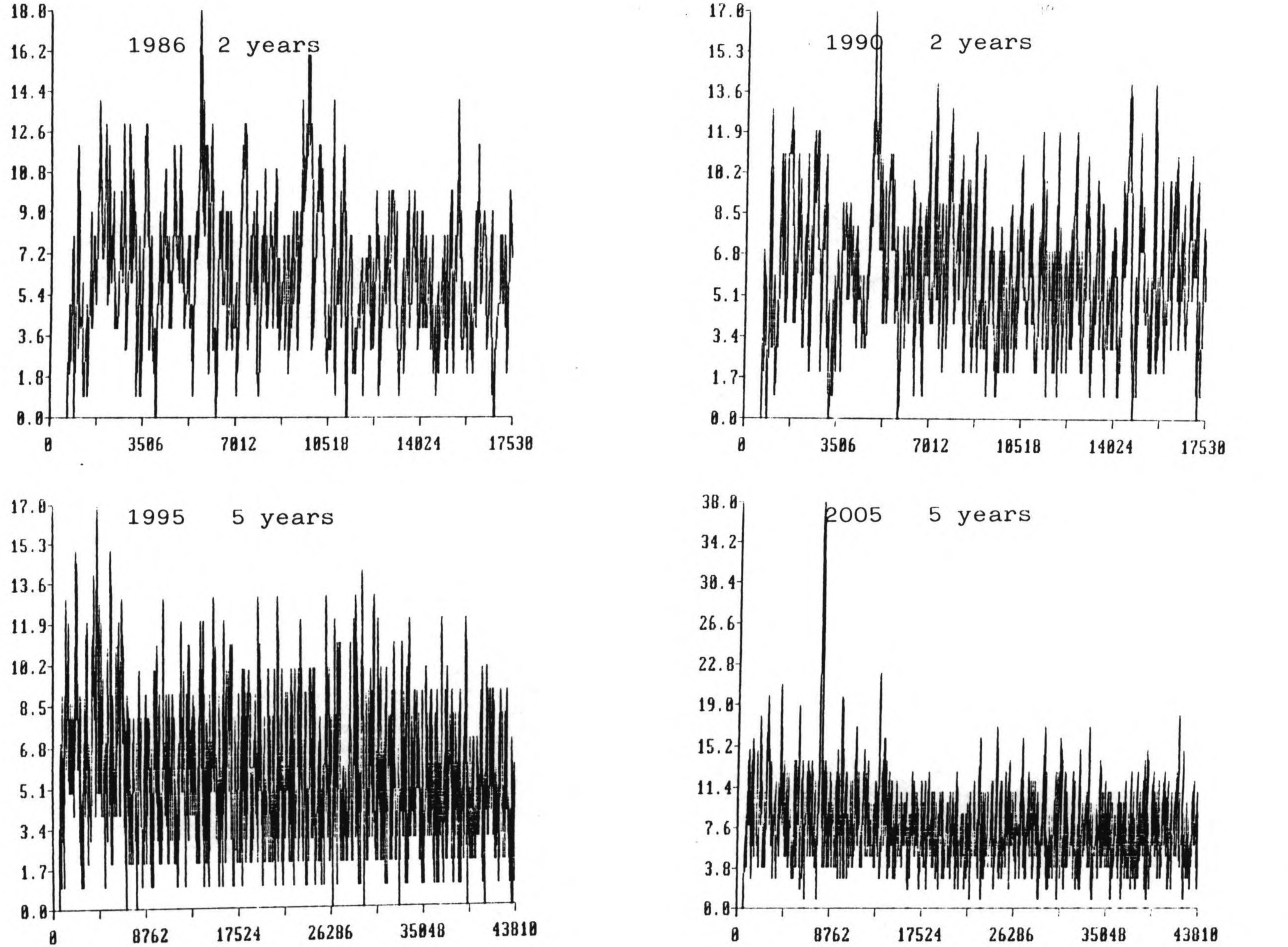
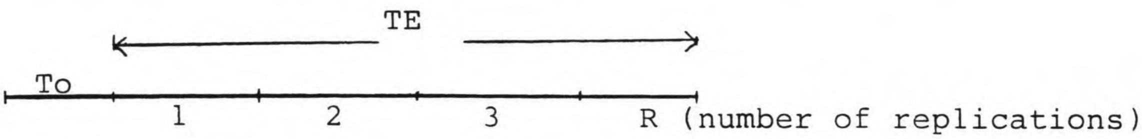


figure 3.3.a Cycle length of 1986
1990 1995 and 2005 situation.

Although, this method gives a completely independent observation, the main disadvantage of this method is that each run requires an initialiszation period, so much of the simulation time may be unproductive. Thus, this method will not be employed.

(3) One continuous run Method.
One simulation run divided into a number of consecutive subruns, using the ending condition on one run as the steady-state starting condition for the next run. Like the second method above, the initialization period is needed before a series of observations is recorded. This method is illustrated below:



This disadvantage of this method is that it does not eliminate the correlation between observations entirely. However, it can be reducely considerably by making the subrun sufficiently long, so that the relation between subruns can be statistically independent.

Finally, the simulation time using the third method above is calculated as follows:

Determination of To

The runs to determine To are optional, the user could always specify long period of To to ensure steady state results, for example 18 months [3]. However, the very long To would imply a waste of computing time in all experimentation runs. The criterion used for determination To, in principle, is that at the time To, the state of system should be in situation which exists in reality. In this study, the state of system regarding monthly number of ship arrival, monthly total ship's waitingtime, berth occupancy ratio (BOR) based on monthly data, and the daily amount of domestic cargo in shed; haven been collected during a set of special runs (1986 situation), summarized in table 3.1 and plotted in figure 3.3.

Table 3.1. State of 1986 MPT system for To determination.

Month	Monthly number of ship arrival	Monthly Total ship's waiting time hrs	BOR	Remark
1	0	0	0	the data
2	58	0	26.18	regarding
3	80	30.36	49.53	the daily
4	76	40.26	51.49	amount of
5	79	0	43.69	domestic
6	77	114.38	42.66	cargo in
7	64	118.80	54.19	
8	84	302.26	60.14	
9	-	-	42.90	
10	-	0	41.41	
11	-	-	48.15	
12	-	100.38	36.93	

From the figure 3.3 it can be seen that the utilization phase of 3 months is sufficient for MPTSIM model to meet the criterion mentioned earlier.

Determination of TE

The length of time TE should be determined with the following considerations: confidence level (say 90%), a specified accuracy (say 5%), and budget/time constraints on computer resources. In the replicative simulation, TE is equal with the number of replication (RJ multiplied by the replication/subrun period (tR).

In a steady-state simulation, the specified accuracy may be achieved either by increasing R or by increasing tR.

Because the shorter tR the more significant corelation between results of subruns, thus tR should be taken long enough so as to the results of subruns are statistically undependent. The method and formula used for R determination and tR investigation are outlined below:

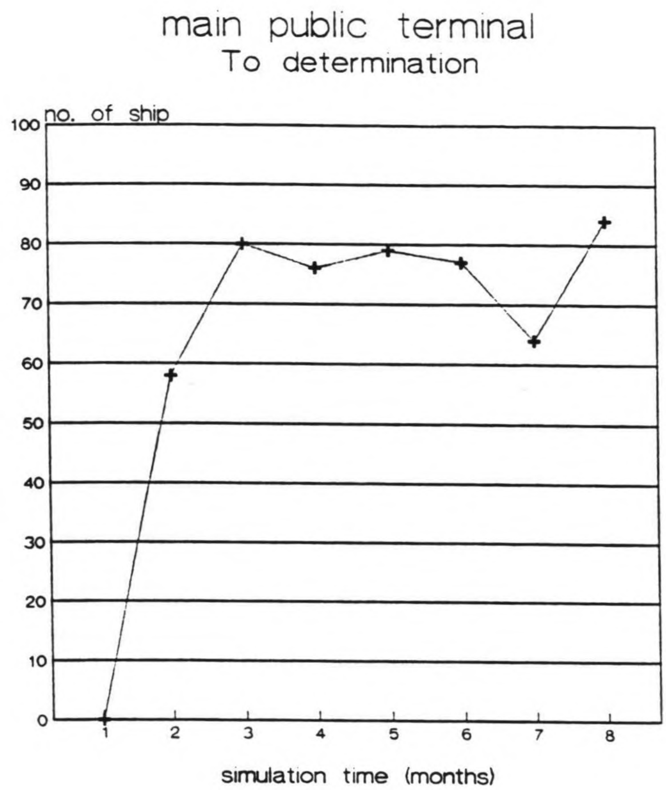
For sample series (in this study: BOR) Y1, Y2 ...Yn

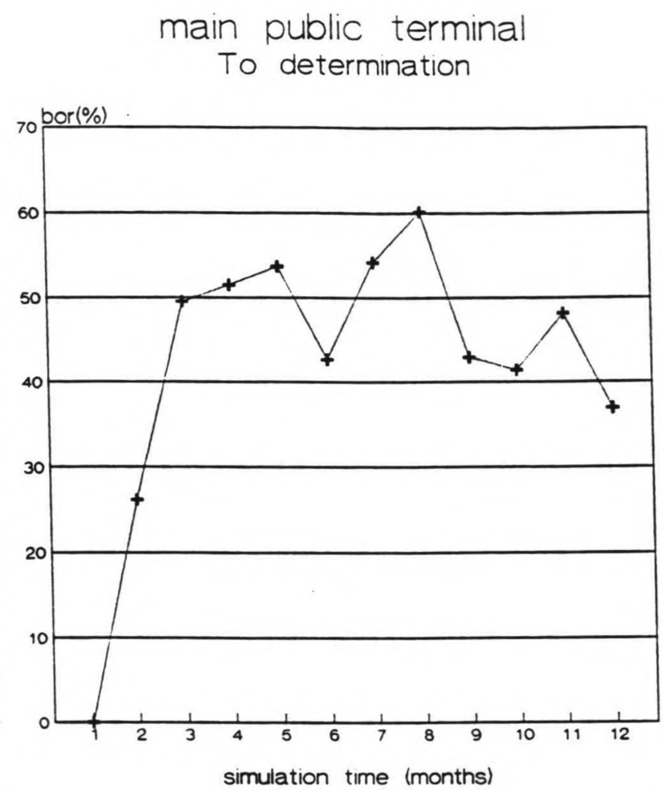
a. The number of replication R is the smallest unteger satisfying the inequality [1]:

$$R \geq \left(\frac{Z * S}{a * \bar{Y}} \right)^2$$

where: - the sample variance $S^2 = \sum \frac{(Y_i - \bar{Y})^2}{n-1}$

- Z = 1.645 for confidence level of 90%
- accuracy a = 5 %
- Y = average of sample data





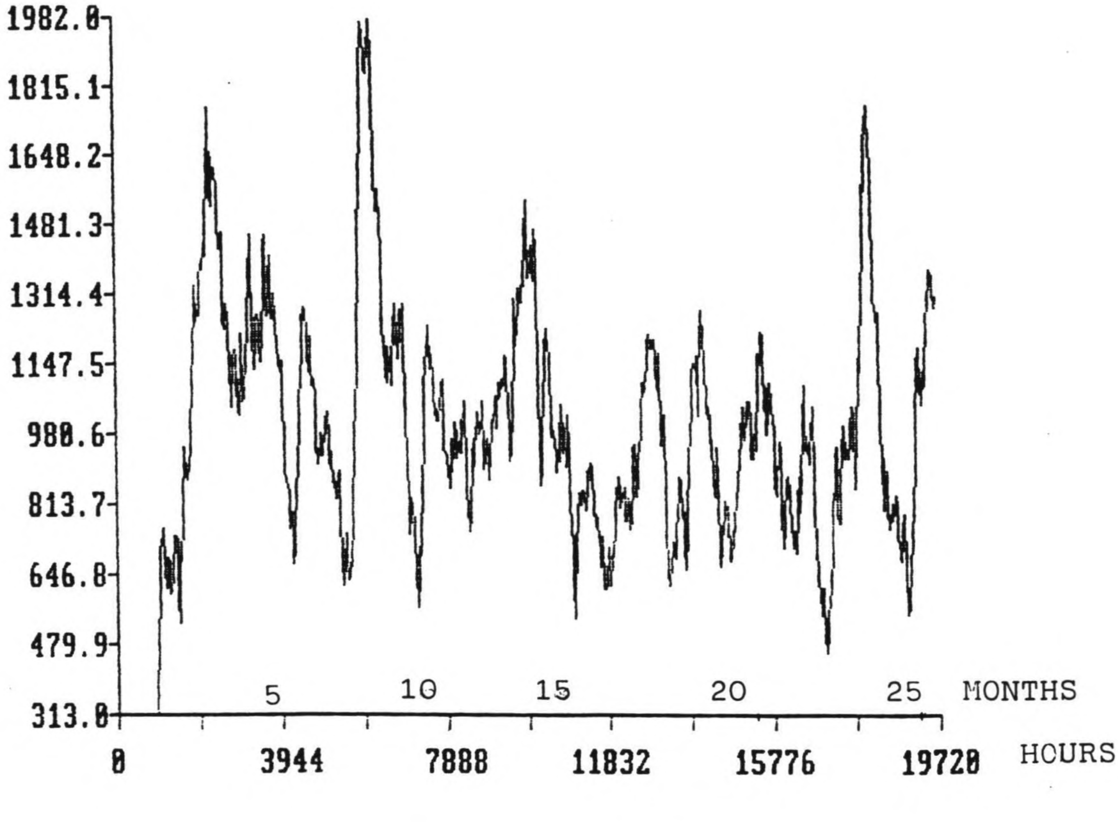


figure 3.3 To Determination.

b. The replication periode (tR) has to fulfill the condition that the series of Y1, Y2, Yn is statistically independent. This question will be investigated using the Mean Square Successive Difference (S2) Method:

$$S^2 = \frac{1}{n-1} \sum_{i=1}^{i-1} (Y_{i+1} - Y_i)^2$$

The sample variance is defined $s^2 = \frac{1}{n} \sum (Y_i - \bar{Y})^2$

Thus the von Neumaan ratio: $K = \frac{s^2}{S^2}$

if K < k : positive correlation
K > kl : negative correlation
k < K < kl : no correlation

the value k and kl are found from table 3.2 below. Take significance level of 5% or P = 0.05.

5% and 1% Significance Points for the Ratio of the Mean Square Successive Difference to the Variance

Values of $\frac{\delta^2}{s^2}$ for Different Levels of Significance

	Values of k		*Values of k'*	
n	*P* = .01	*P* = .05	*P* = .95	*P* = .99
4	.8341	1.0406	4.2927	4.4992
5	.6724	1.0255	3.9745	4.3276
6	.6738	1.0682	3.7318	4.1262
7	.7163	1.0919	3.5748	3.9504
8	.7575	1.1228	3.4486	3.8139
9	.7974	1.1524	3.3476	3.7025
10	.8353	1.1803	3.2642	3.6091
11	.8706	1.2062	3.1938	3.5294
12	.9033	1.2301	3.1335	3.4603
13	.9336	1.2521	3.0812	3.3996
14	.9618	1.2725	3.0352	3.3458
15	.9880	1.2914	2.9943	3.2977
16	1.0124	1.3090	2.9577	3.2543
17	1.0352	1.3253	2.9247	3.2148
18	1.0566	1.3405	2.8948	3.1787
19	1.0766	1.3547	2.8675	3.1456
20	1.0954	1.3680	2.8425	3.1151
21	1.1131	1.3805	2.8195	3.0869
22	1.1298	1.3923	2.7982	3.0607
23	1.1456	1.4035	2.7784	3.0362
24	1.1606	1.4141	2.7599	3.0133
25	1.1748	1.4241	2.7426	2.9919
26	1.1883	1.4336	2.7264	2.9718
27	1.2012	1.4426	2.7112	2.9528
28	1.2135	1.4512	2.6969	2.9348
29	1.2252	1.4594	2.6834	2.9177
30	1.2363	1.4672	2.6707	2.9016
31	1.2469	1.4746	2.6587	2.8864
32	1.2570	1.4817	2.6473	2.8720
33	1.2667	1.4885	2.6365	2.8583
34	1.2761	1.4951	2.6262	2.8451
35	1.2852	1.5014	2.6163	2.8324
36	1.2940	1.5075	2.6068	2.8202
37	1.3025	1.5135	2.5977	2.8085
38	1.3108	1.5193	2.5889	2.7973
39	1.3188	1.5249	2.5804	2.7865
40	1.3266	1.5304	2.5722	2.7760
41	1.3342	1.5357	2.5643	2.7658
42	1.3415	1.5408	2.5567	2.7560
43	1.3486	1.5458	2.5494	2.7466
44	1.3554	1.5506	2.5424	2.7376
45	1.3620	1.5552	2.5357	2.7289
46	1.3684	1.5596	2.5293	2.7205
47	1.3745	1.5638	2.5232	2.7125
48	1.3802	1.5678	2.5173	2.7049
49	1.3856	1.5716	2.5117	2.6977
50	1.3907	1.5752	2.5064	2.6908
51	1.3957	1.5787	2.5013	2.6842
52	1.4007	1.5822	2.4963	2.6777
53	1.4057	1.5856	2.4914	2.6712
54	1.4107	1.5890	2.4866	2.6648
55	1.4156	1.5923	2.4819	2.6585
56	1.4203	1.5955	2.4773	2.6524
57	1.4249	1.5987	2.4728	2.6465
58	1.4294	1.6019	2.4684	2.6407
59	1.4339	1.6051	2.4640	2.6350
60	1.4384	1.6082	2.4596	2.6294

SOURCE: Reproduced by permission of the editors, from B. I. Hart, "Significance levels for the ratio of the mean square successive difference to the variance," Annals of Mathematical Statistics, 13, No. 4, 1942, pp. 445–447.

For the purpose of TE determinations a set of special runs have been carried out. The analysis of the outputs (regarding BOR, see table 3.3 and figure 3.4) just as follows:

Table 3.3 BOR for TE determination.

Yi (=BOR)	12	6	3	2
1	45.53	46.89	49.89	51.50
2	39.90	44.17	48.39	44.50
3	45.50	37.43	45.40	41.50
4	43.98	42.36	47.53	60.00
5	47.32	49.00	40.81	38.00
6	40.00	42.01	33.80	40.00
7	49.50	43.75	41.06	35.00
8	41.70	44.20	42.92	37.00
9	43.18	44.02	41.81	41.50
10	47.18	50.62	49.66	35.50
11			44.32	44.50
12			39.31	41.00
13			44.69	50.00
14			40.77	40.50
15			46.73	58.50
16			43.18	40.00
17			45.21	30.00
18			49.81	53.50
19			38.22	29.50
20			56.34	52.50
21				46.00
22				44.00
23				44.00
24				43.00
25				43.50
26				54.00
27				37.50
28				56.00
29				47.50
30				48.00

The example of detailed calculation is shown only for tR = 12 months.

a. R determination

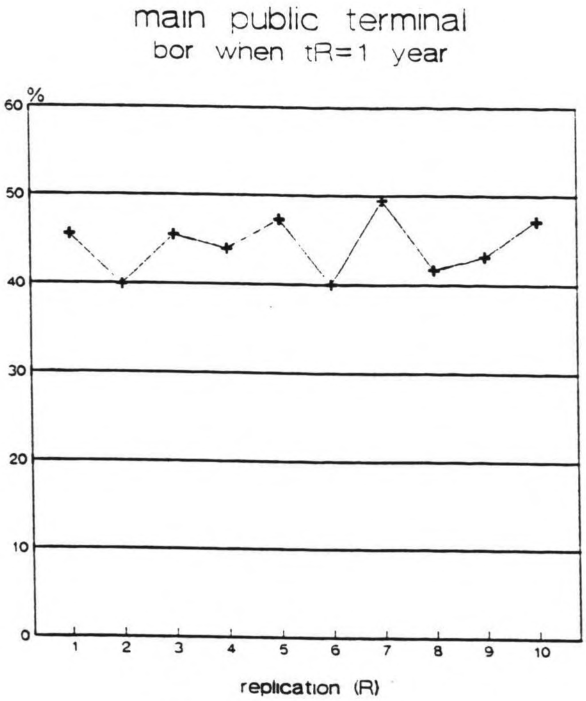
trial 1   R1 = 10 (all) $\bar{Y}$ = 44,38, S = 3.22

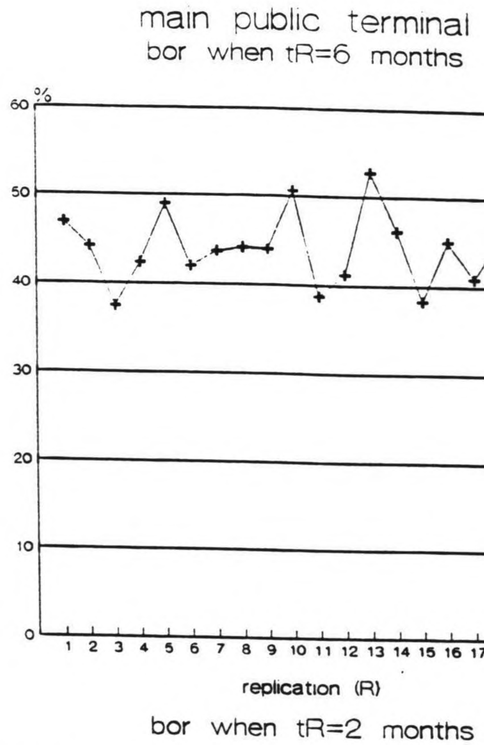
$$R \geq \left(\frac{1.645 * 3.22}{0.05 * 44.38}\right)^2 = 6$$

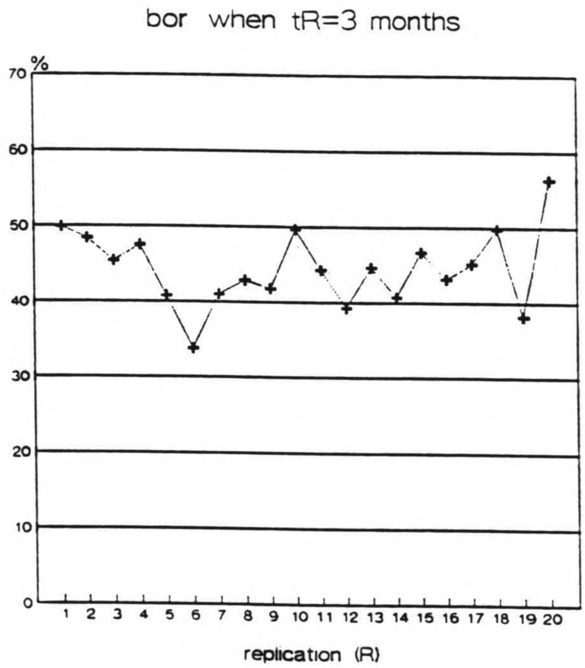
trial 2   R2 = 6 $\bar{Y}$ = 43.70, S = 3.10

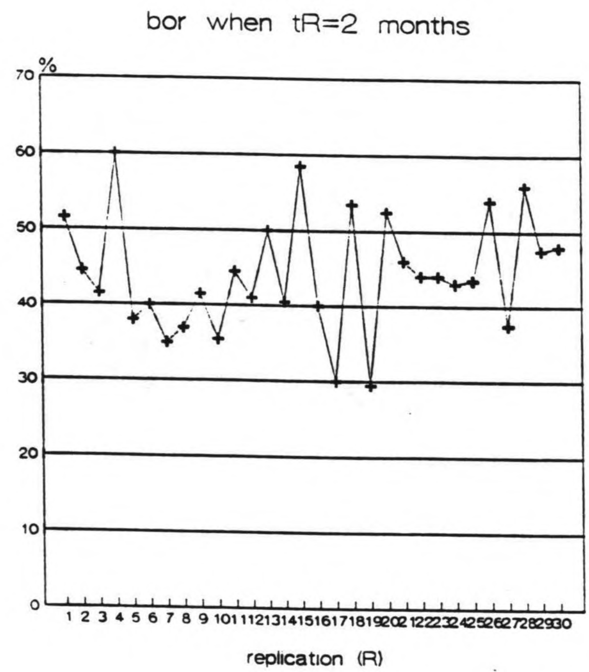
$$R \geq \left(\frac{1.645 * 3.10}{0.05 * 43.70}\right)^2 = 6$$

Take R = 6









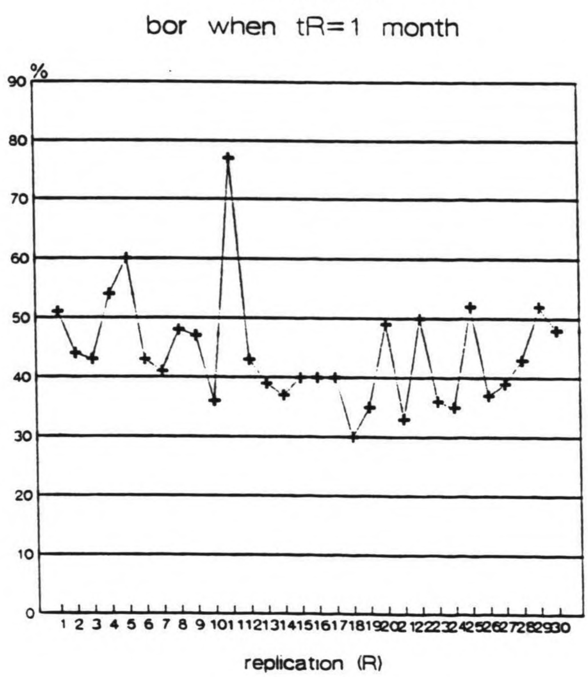


figure 3.4
BOR for tR determination.

b. Independency investigation
for Y1, Y2 Y6:

$s^2 = 26.04$

$S^2 = 7.98$

$$K = \frac{s^2}{S^2} = 3.26$$

From table 3.2 (with P = 0.05):
k = 1.0682
kl = 3.7318
Thus k < K < kl no correlation or independent.

Finally, the R determination and independency investigation for all alternative of tR is sumarized below:

Table 3.4. Summary of TE calculation.

No	tR months	R	TE years	correlation					
				s2	S2	K	k	kl	+ pos. - neg. o no
1	12	6	6	26.04	7.98	3.26	1.07	3.72	0
2	6	8	4	24.76	10.34	2.39	1.12	3.45	0
3	3	13	3 1/4	25.97	19.34	1.34	1.25	3.08	0
4	2	34	5 2/3	156.70	58.31	2.69	1.47	2.67	-

The relationship between tR and TE is plotted in the figure 3.5.

Thus, the shortest TE = 3 1/4 year, achieved by 13 replications of 3 months.

However, from the experience, the 3 1/4 year simulation would take more than 2.5 hours computing time. For the sake of practice, therefore TE will be taken 2 years (8 replications of 3 months).
Finally, the simulation time consists of To = 3 months, and TE = 2 years.

<u>Note:</u>

For R = 8 and tr = 3 months, and convidence level of 90%; the accuracy level can be calculated as follows:

See table of BOR (tr = 3 months)

BOR = 43.72
S = 5.23

a > 7 %

Thus the accuracy level is 7%.

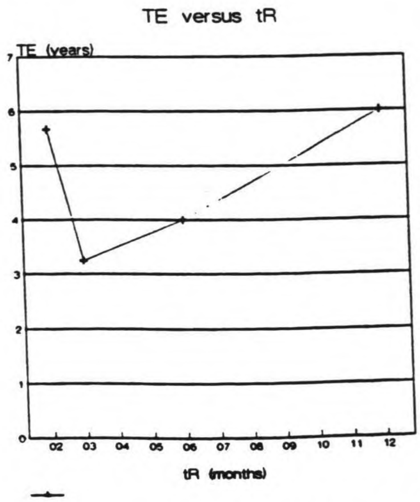


figure 3.5

3.3.5 Validation

The validation approach employed in this study is a comparison between data generated by model and the corresponding data obtained from the real system. The 1986 data concerning the berthing time and berth utilization of each ship's type have been collected. Actually the other data concerning ship's waiting time (for berthing) are useful, but unfortunately no separate record of this waiting time was found. The available data found in the STP-3 sheet are summarized below:

Ship's type	Average Berthing time (hrs)	BOR (%)
Samudra	47.7	9.78
Nusantara	48.3	9.58
Lokal	77.9	14.22
Khusus	90.6	8.52
Total		42.10

A special run (R = 8, tR = 3 months) has been executed so as to produce outputs of berthing time and berth utilization for each ship's type. The comparison of model generated data and actual data is summarized in table 3.5. This table shows that the actual data reside within the interval of 95% confidence level of model generated data.

3.3.6 Experimentation

The experimentation runs are arranged based upon the port development strategy mentioned in the chapter I. Because the Inpres 4/85 is essentially a radical measures in the institutional improvement, any further possible such improvement will not be anticipated in the future. Therefore, the alternative starts from the operation improvement, in this case the working time. In order to show the impact of this measures, the experimentation runs will be started from the actual situation (1986). If later, the operation improvement cannot solve the problem, the modification, or even expansion or construction new facilities will be considered.

Table 3.5. Comparison Model Generated Data with

	Average Berthing Time (hrs)	Berth Utilization BOR (%)
Samudra		
. Actual	(47.70)	(9.78)
. Model-Average	40.49	11.08
-Deviation	4.90	3.43
Nusantara		
. Actual	(48.30)	(9.58)
. Model-Average	42.26	9.84
-Deviation	3.50	2.65
Lokal		
. Actual	(77.90)	(14.22)
. Model-Average	73.48	14.08
-Deviation	2.59	2.24
Khusus		
. Actual	(90.60)	(8.52)
. Model-Average	72.97	8.81
-Deviation	11.60	2.80
Total		
. Actual		(42.10)
. Model-Average		43.82
-Deviation		5.95

There are two aspects in the working improvement which will be considered:

1. Working time.
   This indicates the available working hour per day. The present cargo handling operation takes place during more or less 9 day-light hours per day. The implementation of multishift working system is meant to prolong working time, to 16 hours and 24 hours per day in the two-shift working system and in the three-shift working system respectively.

2. Productivity level.
   The cargo handling rate of non-shuttle ships derived by consultant (see Annex B3) based on 1982 data,
   - covers stops or interruptions during operation, since these rates are found from the amount of cargo handled during hours effectively used for loading/discharging of cargo. Thus these rate are considered realistic.
   - do conform with data known from other ports working under similar condition [7].
   - is not expected that they can be significantly increased because the cargo handling is mainly carried out under direct contract (borongar) [7].

The cargo handling for shuttle-ships estimated by consultant covers also 10% of time for shifting spreader to next hatch (container operation) of 10% of time for interuption during operation.
Furthermore, the rain effect to the cargo handling operation can be considered negligible. Despite the fact that Palembang has about 2800 mm of rain per year, cargo handling operation are surprisingly little effect affected by rain. Most of the rain occurs in the evening in very hard but short rainstorms. The Operations Divisions estimates that the time lost due to weather is in the order of 5%. However, a short rainstorm on hot sun day, which may slow down the port operation, will generally cool the atmosphere somewhat and the time lost due to the rain may be regained in added productivity following the cooling shower [7].

Another lost days each year is about 15 days (4% of time) for unavailable berth maintanance. If long queue of ships are to be avoided, the berth should only be occupied not more than ca. 75% of available time a year. Thus, it becomes flexible to organize the berth maintanance be carried out when the berth is not occupied. It is assumed that another lost day each year in public holidays (say 10 days, 2,5% of time) is not taken into consideration.

However, the introduction of multi-shift working system means that part of cargo handling operation will be performed during night hours. It well-known fact that in general cargo terminal, handling cargo mainly by hand (thus applies for non-shuttle ships), it is not possible to maintain the same cargo handling rate at night as during day time. The following levels of effective production (in comparison with productivity during day light operation), have been considered as realistic and obtainable in practice [7]:

- during 12 night-time hours:
  from 18:00 to 06.00 - 50% effective production
- during 12 daylight hours:
  from 06:00 to 08:00 - 75% effective production
  from 08:00 to 18:00 - 100% effective production.

For shuttle ships, with assumption that the cargo handling operation is almost entirely carried out mechanically by rather highly trained and skilled operator, the effective production of 100% is expected to be maintained during night hours as well.

In present cargo handling operation, however, only part of the available hours (9 hour) per day is effectively used for loading and discharging operation (see Annex B3) ranges from 34 to 64%. It is expected that the introduction of prearrival planning, work schedulling and performance review, together with the synchronization of different working time of all parties involved in cargo handling operation will increase the effective hours for loading/discharging operation. For present working time of 9 hours, it is estimated that 90% (optimistic) or 70% (pessimistic) will be achieved for non-shuttle ships (100% for shuttle ships). For multishift system, it is assumed that all available hours can be used for cargo handling operation.

In connection with the effective production related to daylight operation and the percentage of effective hours used for cargohandling operation, the term of productivity level is introduced here. The productivity level indicates the ratio of equivalent effective hours to the working time. One equivalent effective hour is one effective hour with cargo handling rate of daylight operation.

Alternatives of working situation

(1) Alternative I

Present working time of 9 hours/day with present productivity

level of 35 - 70% are applied for non-shuttle ships (see Annex B3).
Whereas for shuttleships, two-shift working time of 16 hours/day is considered suitable. With assumption that the cargo handling is almost entirely carried out mechanically by rather highly trained and skill operator, the productivity level can be expected 100% during the operation time.

(2) Alternative II

- For non-shuttle ships:
  The cargo handling takes place only during the present working time of 9 hours/day. With assumption that the synchronization measure of the working time together with the implementation of operation planning (see Chapter I), will increase the productivity level to 70% (pessimistic estimate) of 90% (optimistic estimate).
- For shuttle-ships: similar to the Alternative I.

(3) Alternative III

- For non-shuttle ships.
  The introduction of two-shift working system of 16 hours/day, which consists of:
  Shift I : 08.00 - 16:00
  Shift II : 16:00 - 24:00

  With assumption that the productivity level of cargo handling during 12 night-time hours (from 18:00 to 06:00), during 2 day-light hours (from 06:00 to 08:00) and during other day- light hours (from 08:00 to 18:00) are about 50%, 75% and 100% respectively; the productivity level for two- shift working system of non- shuttle ship is approximately 80%.
- For shuttle ships:
  The introduction of three-shift working system of 24 hours/day. The productivity level of 100% is assumed to be maintained during the whole operation time.

(4) Alternative IV:

The introduction of three-shift working system of 24 hours/day for all ships, which consist of
Shift I : 08:00 - 16:00
Shift II : 16:00 - 24:00
Shift III : 24:00 - 08:00

Using similar assumption of the cargo handling effectiveness above, the productivity level for non-shuttle ships is about 75%. Whereas, the productivity level of 100% is applied for shuttle ships.

In Summary:

	Alternative working Situation I	IIp	IIo	III	IV
- Non-shuttle ship					
Working time (hrs)	9	9	9	16	24
productivity level (%)	35 70	70	90	80	75
- Shuttle ship					
working time (hrs)	16	16	16	24	24
productivity level (%)	100	100	100	100	100

<u>Arrangement of Experimentation Runs</u>

The experimentation runs are arranged as follows:

1. Alternative I, IIo and III will be run for 1986 situation in order to get a picture of the impact of the working improvement.
2. A set of experimentation runs is made for future situation in connection with the berthing capacity. The number of quay crane should be sufficient in order to avoid effect of this crane to the berthing capacity. The runs will involve the five alternatives of working situation above, and other alternatives with regard to the quay extension if necessary.
3. With regard to the quay crane requirement calculation, another set of experimentattion runs will be made only for those situations in 1990, 1995 and 2005, which give solution concerning the berthing capacity on point 2 above.
4. Finally, it may be necessary to set up a set of experimentation runs in connection with the port development project which affect directly to the port capacity. This will be taken into consideration in the Chapter IV.

<u>Result of the Experimentation Runs</u>

1) <u>The Impact of working Improvement</u>
The impact of working improvement will be shown by the port operational cost composion which include ship cost and cargo handling cost, for the 1986 situation with alternative of I, II and III. The component of ship cost in port is onze of the outputs of simulation run, whereas the cargo handling cost will be calculated based on the following assumptions:
   a) The cost of stevedoring, cargodoring, receiving and delivery of cargo are determined based on the Attachment III of the Decree of the Minister of Communications. Number: KM 90/Pr. 302/Phb-85 dated April 11, 1985 on Guidance for the Calculation of the Cargo Handling Tariff in Harbour.

table 3.6

Tariff of Cargo Handling per ton/m3

(in Rp.)

No.	Type of cargo	Ordinary days (Monday - Saturday)								Sundays / Public Holidays							
		Shift I				Shift II/III				Shift I				Shift.II/III			
		stevedoring	cargodoring	receiving delivery	fios	stevedoring	cargodoring	receiving delivery	fios	stevedoring	cargodoring	receiving delivery	fios	stevedoring	cargodoring	receiving delivery	fios
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	General cargo	619	1,006	515	2,140	739	1,238	632	26009	906	1,564	795	3,265	1,097	1937	908	4.018
2	Dry Bulk cargo (in bag)	413	670	344	1472	492	826	421	1739	604	1,043	530	2,177	731	1291	654	2.676
3	Liquid Bulk cargo (in drum)	437	710	364	1511	521	874	446	1841	640	1,104	561	2,305	774	1367	693	2.834

Estimate: 1986: 1 US $ = Rp. 1000,-

cargo handling cost US $/ton:

	stevedoring	cargodoring	receiving/ delivery
Alt I and II	0.68	1.12	0.57
III	0.74	1.25	0.64
IV	0.77	1.31	0.66

b) The transportation cost (by truck) in 1983 between MPT area and shipper/consigner location within the city of Palembang, the maximum charge has been set at Rp. 1200,- per ton [7].

Estimate: during daylight: US $ 1.2 per ton
during nighttime: US $ 1.8 per ton
So, Alt I, II: US $ 1.2 per ton
III: US $ 1.4 per ton
IV: US $ 1.6 per ton

c) The implementation of two-shift working system or more, during which part of operation take place at night-time hour, necessitates the following additional cost:
- for strengthening the security on the river, in the port, on the road and in the areas godowns in the city.
- for transportation cost of port labour, because there is no public transportation at night from their relatively far residence and port area.

In this study, only rough estimate of these additional cost are made:

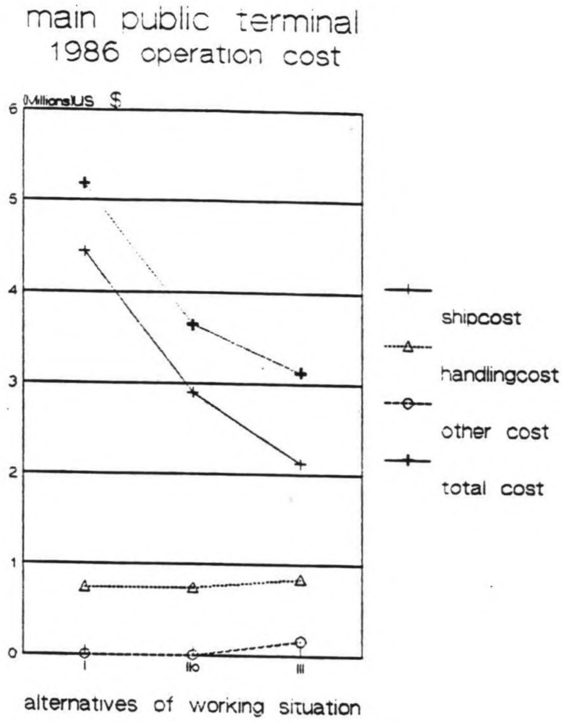
annual cost (US $ 1000) of:	Alt III	alt IV
- security:	100	200
- public transportation for labour:	60	60

Based on the above assumptions, the table 3.7 and figure 3.6 show the operational cost comparison for the 1986 situation, alternative I, IIo and III (in 1000 US $):

Table 3.7. Operation Cost Comparison of 1986 situation for I, IIo and III alternatives.

Cost Component	Alt I	Alt IIo	Alt III
1. Ship			
- Samudra	1648	1232	897
- Nusantara	976	725	545
- Lokal	664	374	275
- Khusus	1152	568	406
Subtotal	4440	2899	2123
2. Cargo			
- stevedoring (of 306.000 tons)	208	208	226
- cargo doring (of 100.000 tons)	112	112	125
- receiving/delivery (of 100.000 tons)	57	57	64
- trucking within Palembang City (of 306.000 tons)	367	367	428
Subtotal	744	744	843
3. Others			
- security	-	-	100
- public transportation for labour	-	-	60
Subtotal	0	0	160
Total	5184	3643	3126

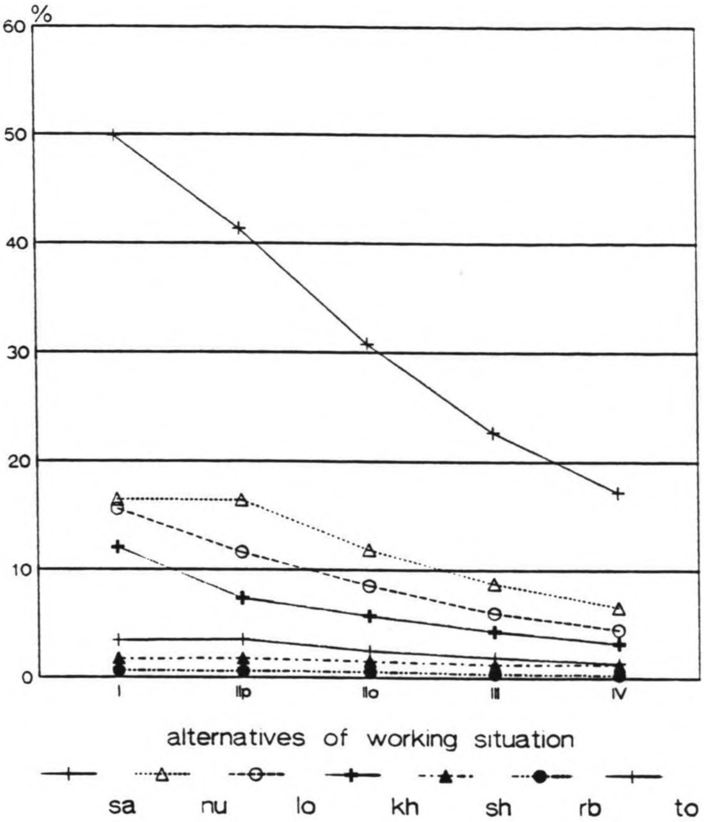
figure 3.6



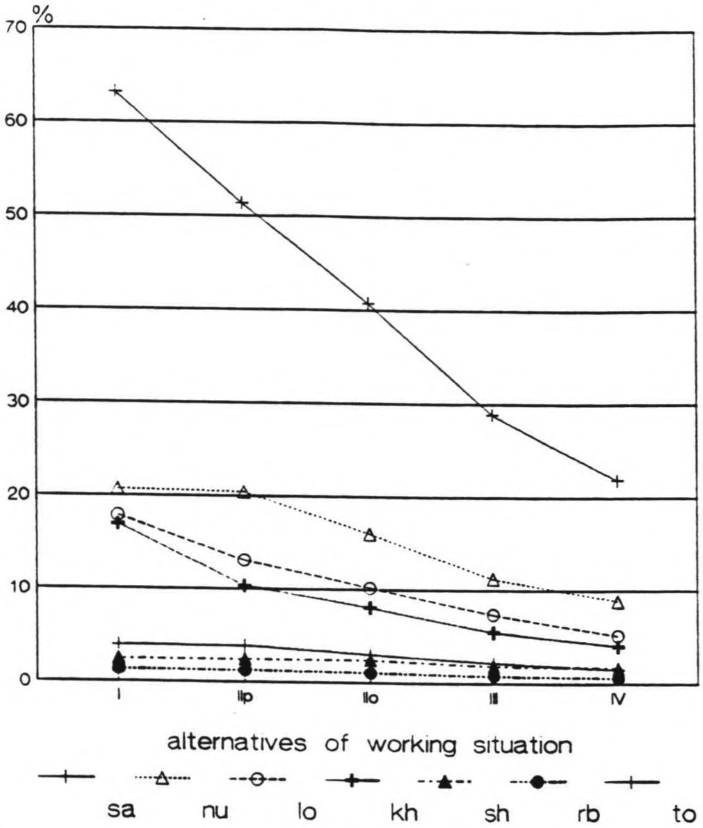
2) Future Situation (1990, 1995 and 2005)

The outputs of the experimentation runs for future situation in 1990, 1995 and 2005 with various alternatives of working time, quay crane, etc. are summarized in the Annex D. However, it is useful to present here various graphs shown in figure 3.7.

main public terminal
1990 berth occupancy ratio



main public terminal
1995 berth occupancy ratio



main public terminal
2005 berth ocpcy ratio

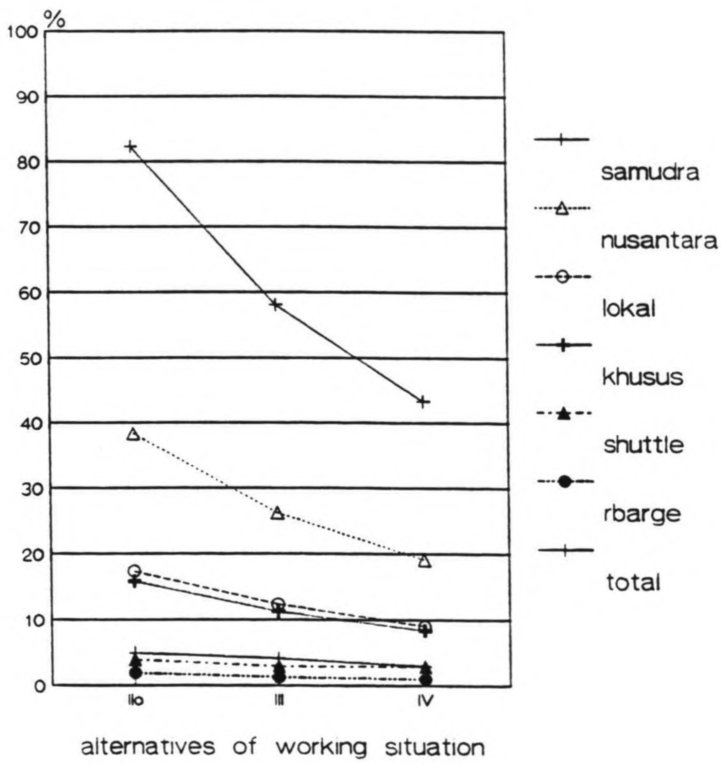
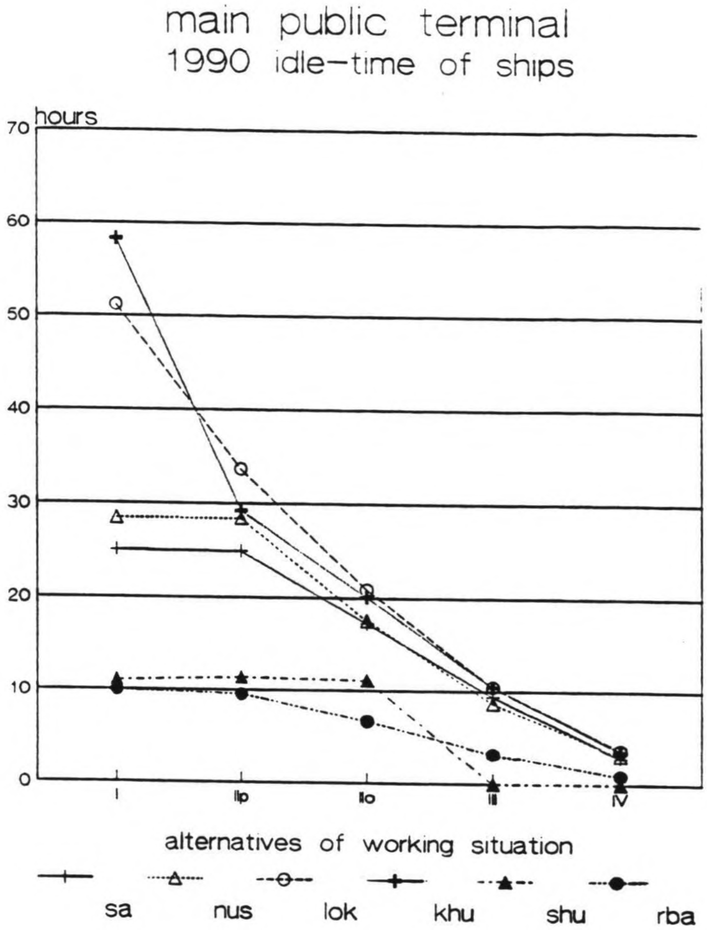
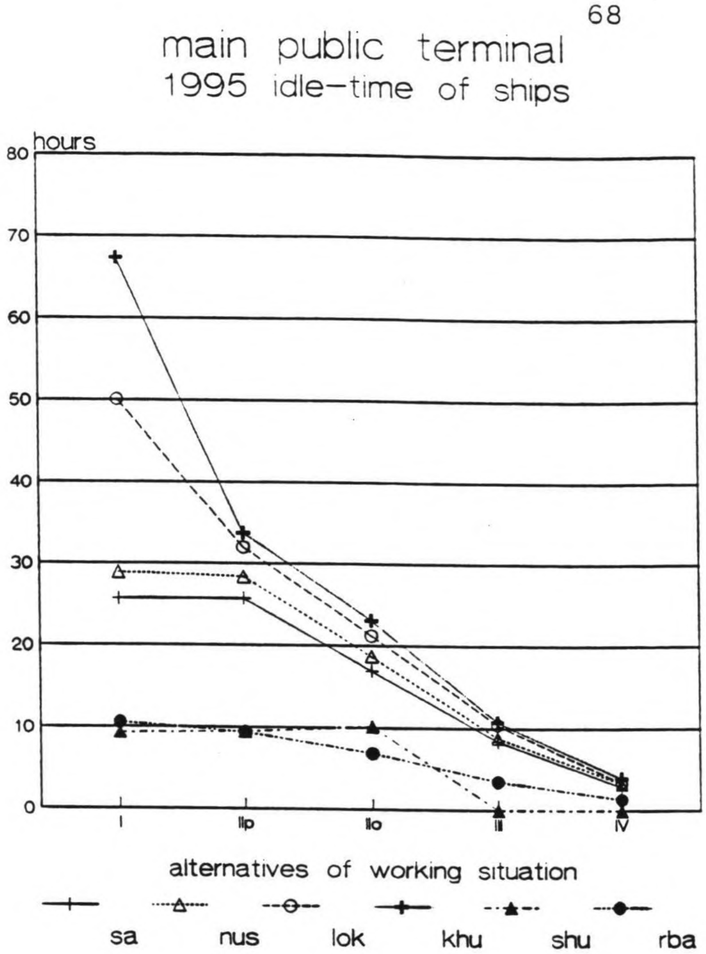


figure 3.7


main public terminal
1990 idle-time of ships
hours
70
60
50
40
30
20
10
0
I
IIp
IIo
III
IV
alternatives of working situation
sa
nus
lok
khu
shu
rba


main public terminal
1995 idle-time of ships
hours
80
70
60
50
40
30
20
10
0
I
IIp
IIo
III
IV
alternatives of working situation
sa
nus
lok
khu
shu
rba

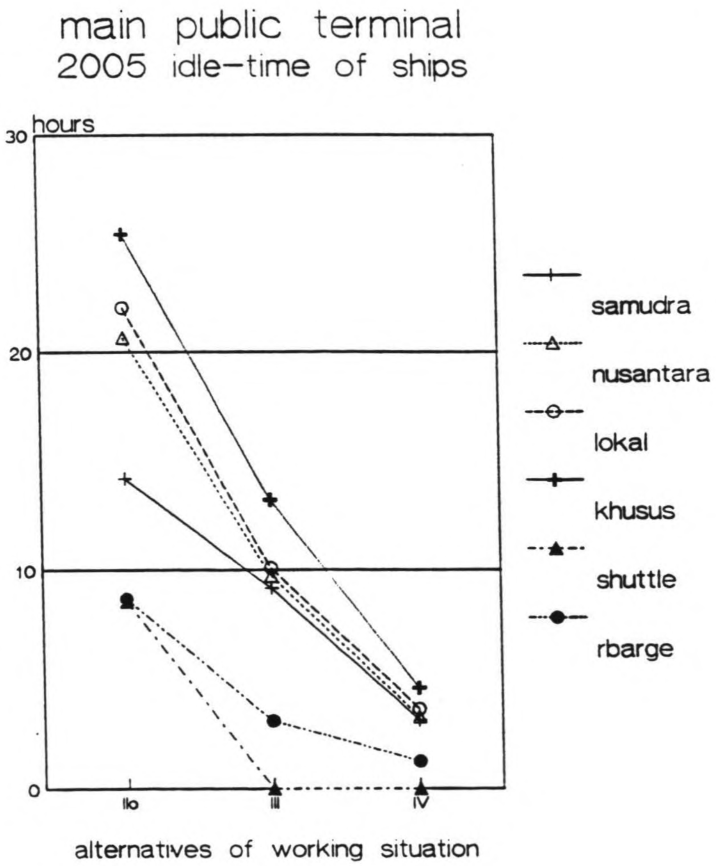
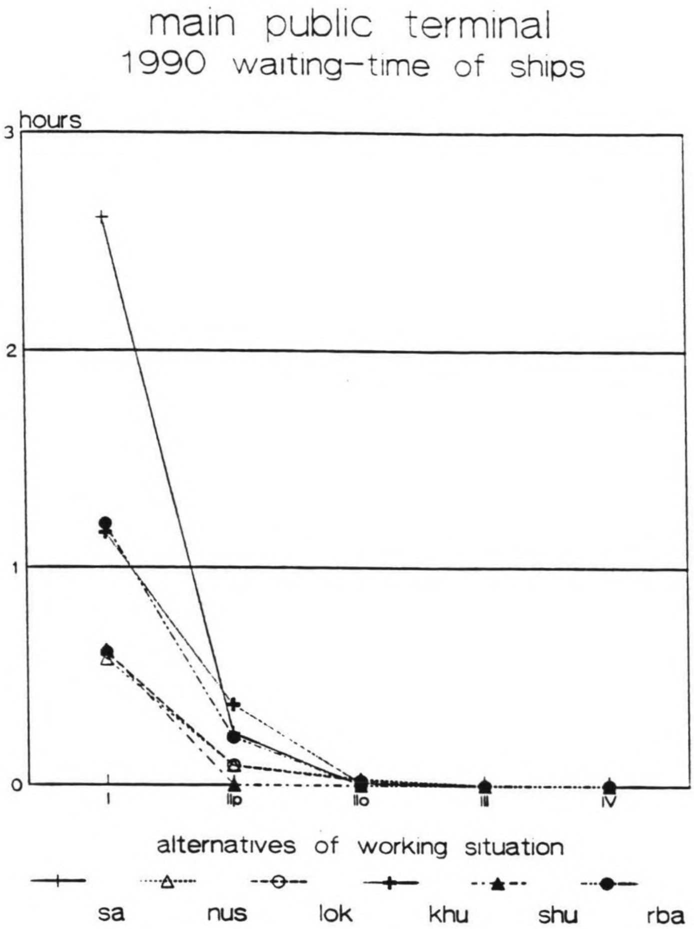
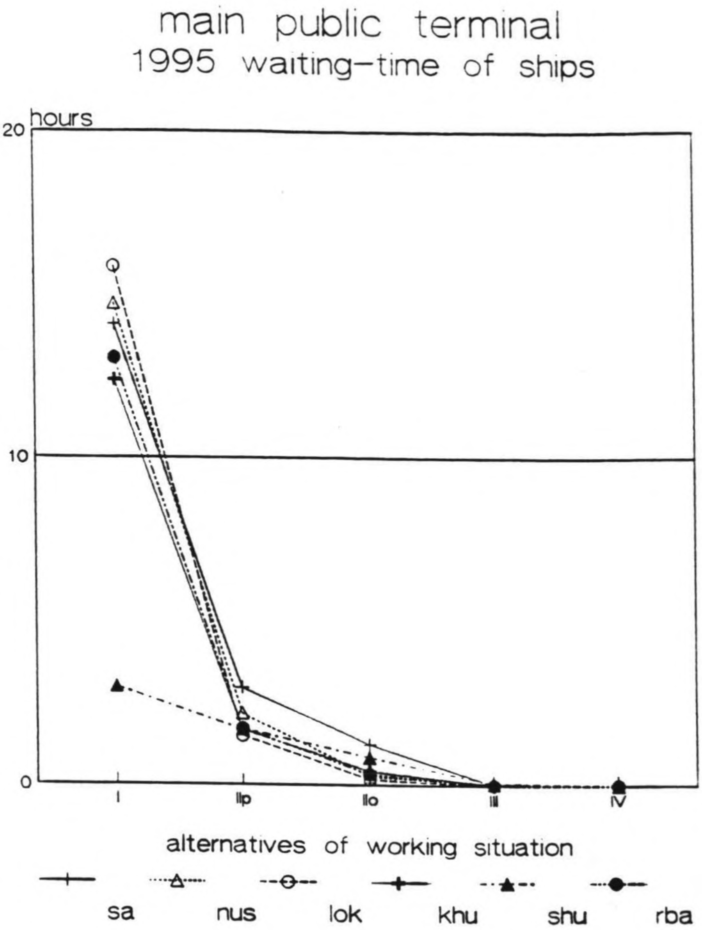

main public terminal
2005 idle-time of ships
hours
30
20
10
0
IIo
III
IV
alternatives of working situation
samudra
nusantara
lokal
khusus
shuttle
rbarge

figure 3.7


main public terminal
1990 waiting-time of ships
hours
3
2
1
0
I
IIp
IIo
III
IV
alternatives of working situation
sa
nus
lok
khu
shu
rba


main public terminal
1995 waiting-time of ships
hours
20
10
0
I
IIp
IIo
III
IV
alternatives of working situation
sa
nus
lok
khu
shu
rba

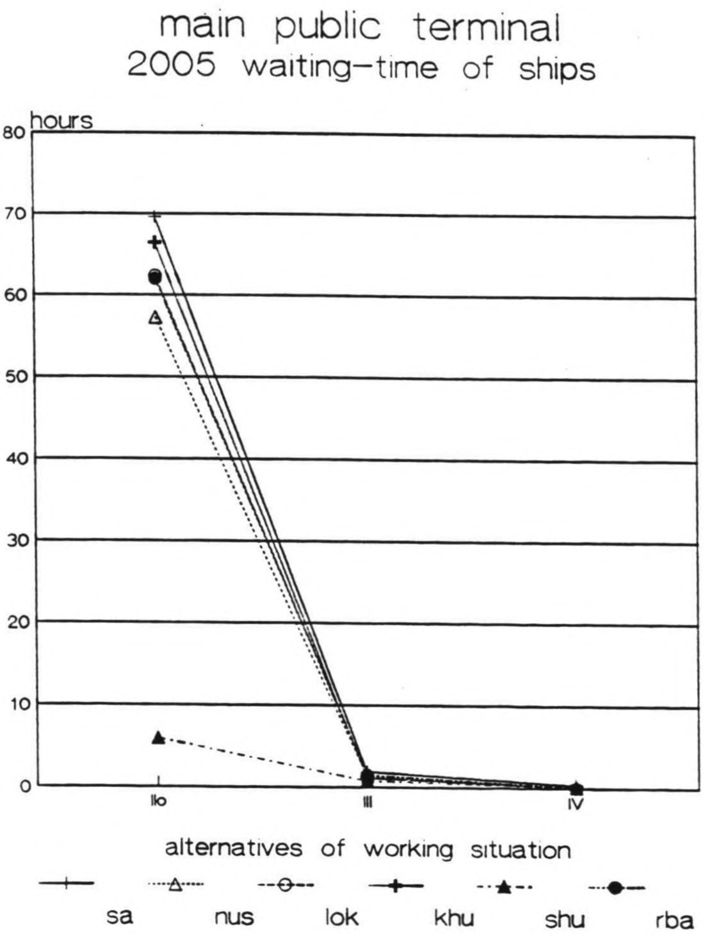
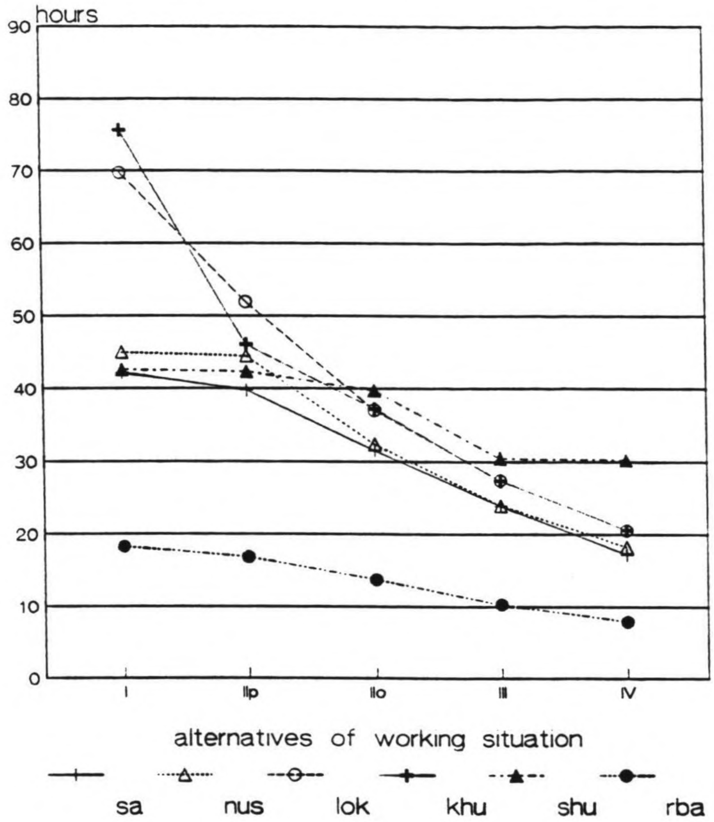
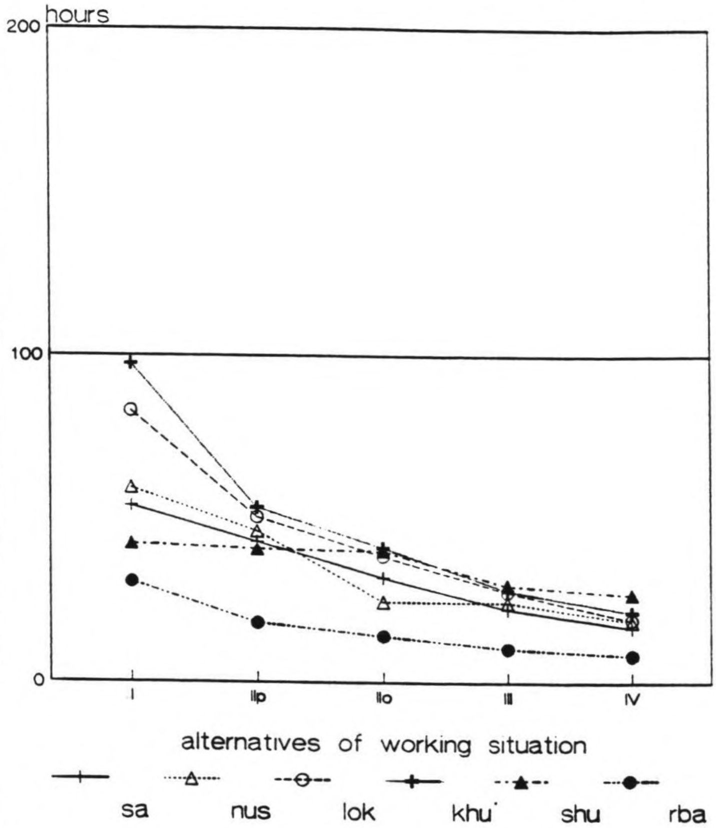

main public terminal
2005 waiting-time of ships
hours
80
70
60
50
40
30
20
10
0
IIo
III
IV
alternatives of working situation
sa
nus
lok
khu
shu
rba

figure 3.7

main public terminal
1990 port-time of ships



main public terminal
1995 port-time of ships



main public terminal
2005 port-time of ships

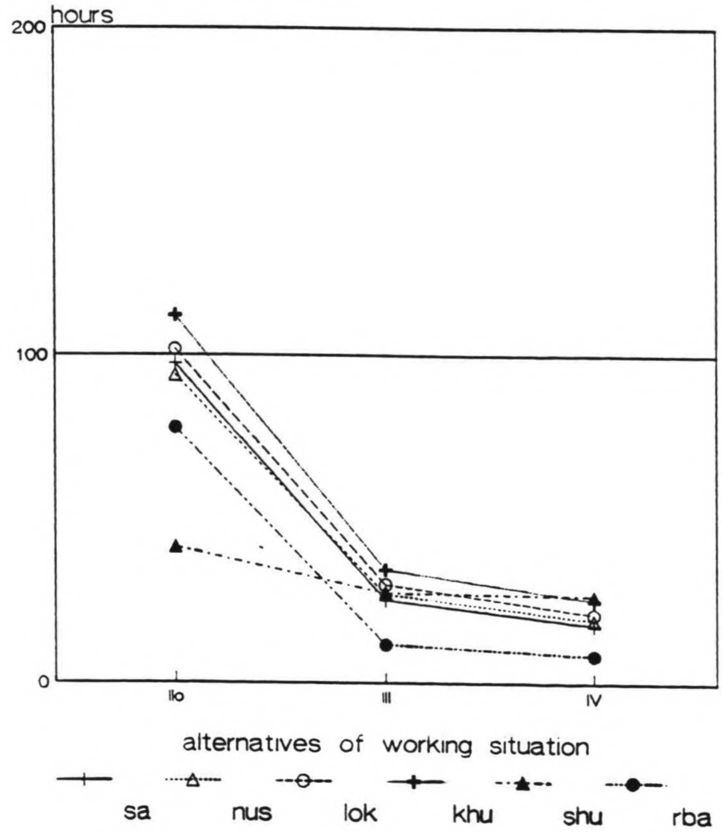
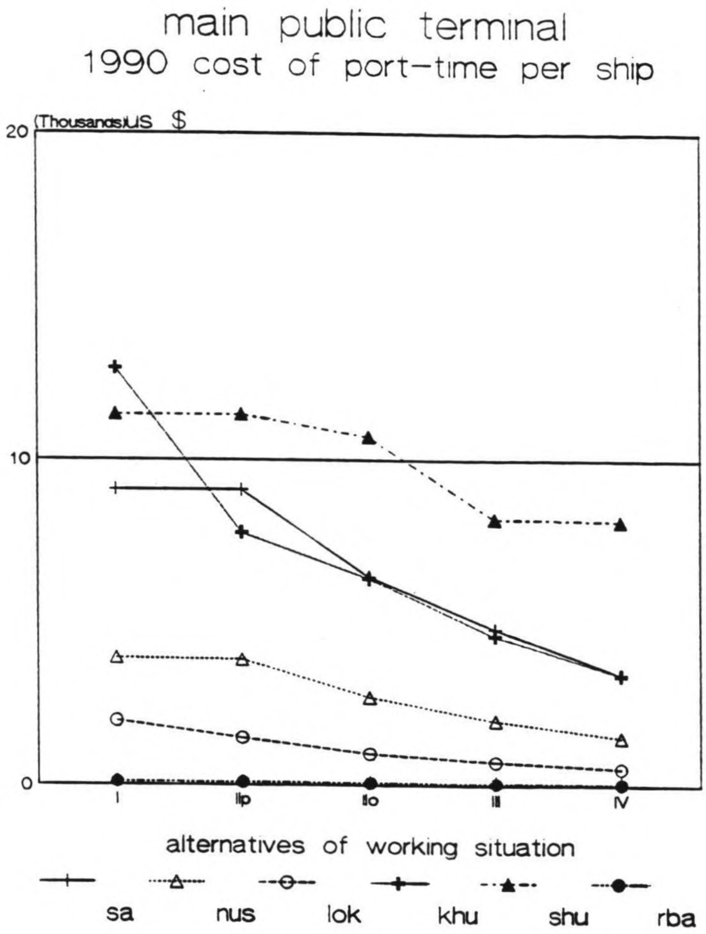
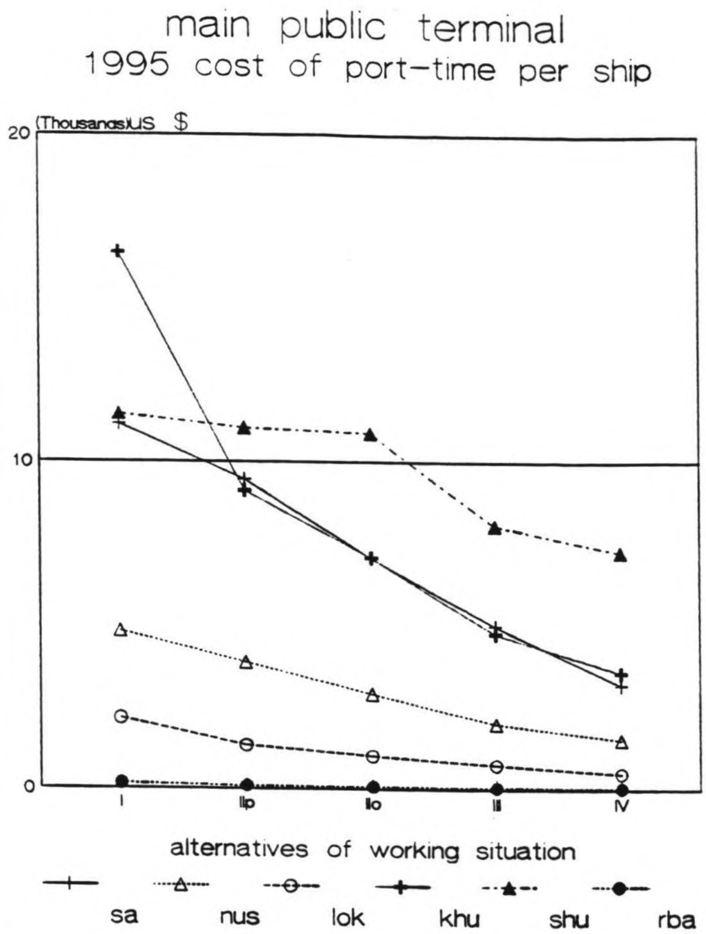


figure 3.7


main public terminal
1990 cost of port-time per ship
(Thousands)US $
20
10
0
I
IIp
IIo
III
IV
alternatives of working situation
sa
nus
lok
khu
shu
rba


main public terminal
1995 cost of port-time per ship
(Thousands)US $
20
10
0
I
IIp
IIo
III
IV
alternatives of working situation
sa
nus
lok
khu
shu
rba

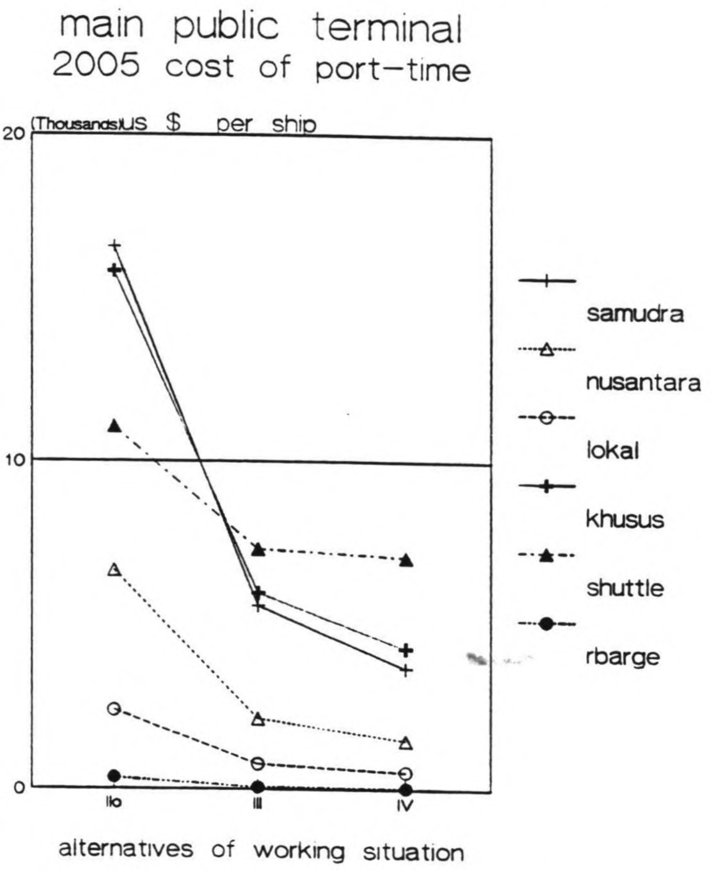
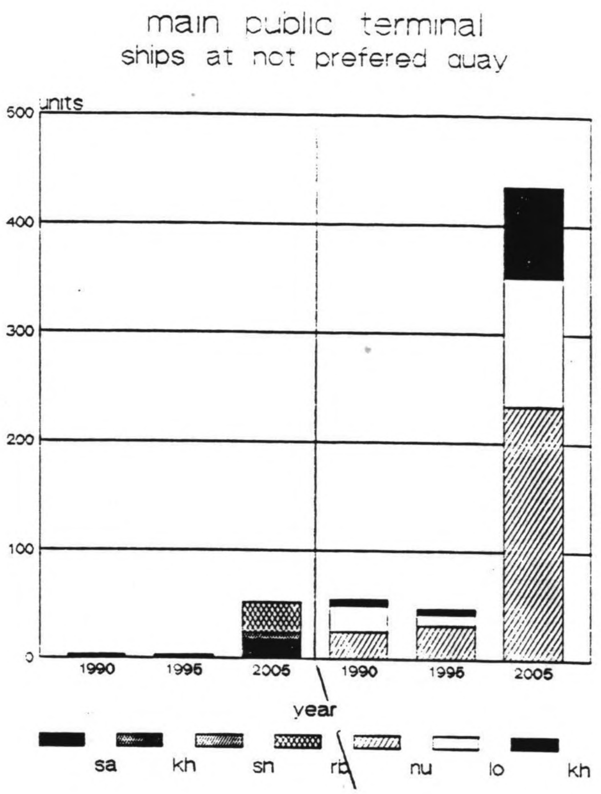

main public terminal
2005 cost of port-time
(Thousands)US $ per ship
20
10
0
IIo
III
IV
alternatives of working situation
samudra
nusantara
lokal
khusus
shuttle
rbarge

figure 3.7


main public terminal
ships at not prefered quay
units
500
400
300
200
100
0
1990
1995
2005
1990
1995
2005
year
sa
kh
sn
rb
nu
lo
kh

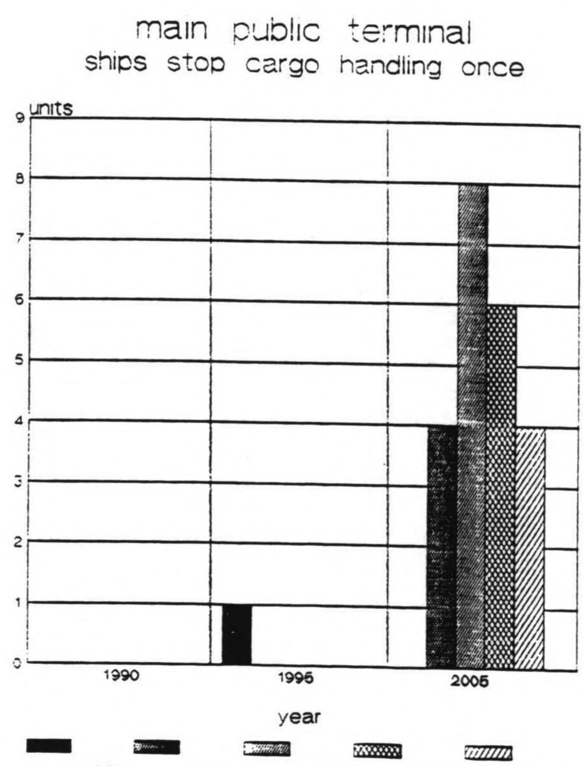

main public terminal
ships stop cargo handling once
units
9
8
7
6
5
4
3
2
1
0
1990
1995
2005
year
samu
nusa
lokal
khusu
rbarg

figure 3.7

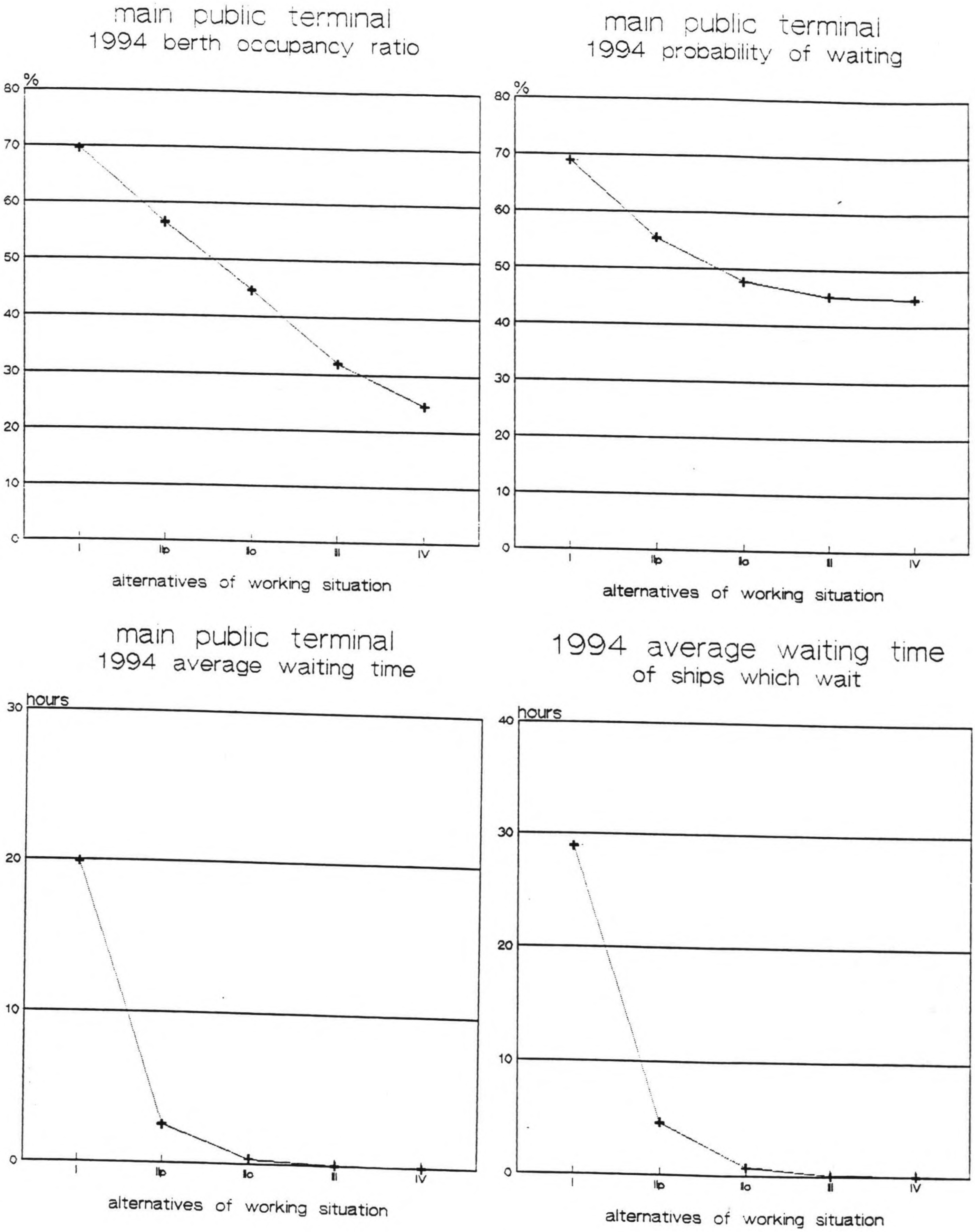


figure 3.8 The 1994 Port Operation Indicators (when the international quay of 100 m being rebuilt)

3) Conclusions

1. The operation improvement measure (in this case the introduction of the multi-shift working time) will have solved the future demand. Therefore, the extension of quay will not be required until 2005.

2. Since the decreasing of cost spent by ship in port is much greater than the additional cost needed for the implementation of the longer working time, therefore if it is possible, the full-scale of multi-shift working time is suggested to be implemented as soon as possible. However, if that can not be achieved, the following gradual implementation is recommended:

Year	1988	1990	1995	2005
Alternative	IIp	IIo	III	IV
where:				
working time (hrs)	9.00	9.00	16	24
eff. (%)	70% (& 100%)	90% (& 100%)	80% (& 100%)	75% (& 100%)

3.4 Future Terminal Facilities

3.4.1 Quay Length

From the previous sub-chapter, it can be concluded that the existing quay length will be capable to accomodate the port capacity needed up to 2005, if during this time horizon the operation improvement (the longer working time and the more effective working) is implemented. Therefore, the extension of existing quay will not be necessary. Thus, up to 2005 the Main Public Terminal has:
- international quay of 360 m, and
- domestic quay of 375 m.

However, the western (upstream) 100 m of international quay is not suitable for container handling equipment, within a normal acceptable level of safety. Redisigning and rebuilding of this part of the quay becomes necessary. It is expected that the existing piles can be incorporated within a new quay design, while deck and beams will require to be removed and completely rebuild [7]. It is planned that the rebuilding of this part of the quay will have been completed by 1995. Thus during the rebuilding period, say in 1994, the operable quay length of international subterminal becomes 100 m shorter, and directly affects the performance of port operation. In order to get information concerning this situation, a set of experimentation runs is done for 1994 in various alternatives of working situation. The outputs are put in Annex D. Some of this outputs are shown in figure 3.8. As far as the working improvement reaches at least alternative IIp (70% effective working), the level of berthing service is still acceptable, where the average waiting time of ships which wait is less than 40% if service time.

3.4.2 Mobile Quay Crane

3.4.2.1 Cranes for Assisting Ship's Gear

These cranes are not incorporated in the MPTSIM model. Therefore, the number of these cranes will be determined with the following assumption.

The shuttle ship unloads and loads containers primarily with its own gear. However, in order to maintain an average loading/unloading productivity of 20 TEU's per hour, a mobile rubber-tired quay side tower crane (of 30 tons cap) is considered to assist the container (un-)loading activity. This crane should also be able to handle other unitized and non-unitized cargoes in the shuttle ship.

As mentioned in the Annex B3, the non-shuttle ship (except Rubber barge) also (un)loads cargoes primarily with its own gear. However a mobile rubber-tired quay side tower crane (of 15 tons cap.) is required for assisting this ship in case of ship'gear breakdown, and also for handling an occasional heavy unit.

3.4.2.2 Cranes for Rubber Barge

These cranes are incorporated in the MPTSIM model. Therefore the number of these crane will be determined based on the outputs of experimentation runs arranged for this purpose. These outputs have been summarized in the previous sub-chapter.

The relationship between the number of these cranes and the amount of time spent by ships is a trade-off. The more the crane (the more availability of these crane), the less the idle time and waiting time of ships. Or in the term of cost, the higher the investment for cranes, the less the cost of ships spent in the port. Therefore the optimum number of cranes is that will give the minimum total cost of those two components of cost.

The requirement of mobile quaycrane for rubber barges operation in 2005, can be calculated as follows:

1. From table 3.4, column 2005, in previous subchapter indicated that either one crane or three employed, the composition of time spent by ships in port, can be

considered similar. This implies that the availability of cranes (even only one) is 100%.

2. In 2005, there are 220 barges which operate mobile crane. The average of this cargo handling operation is 3.03 hour per barge. However, the crane is occupied by barge since this barge will be moored, thus 2 hours before cargo handling take place. Therefore, the occupancy operating hour of that crane is 220 x 5.03 = 1106.6 hours per year. This is still much lower than the maximum permitted annual operating hours of 2400 hours. This fact explains the point 1 above.

Finally, it can be concluded that one mobile rubber-tired quay side tower crane of 10 tons capacity is sufficient for (un)loading operation of rubber barges up to 2005.
However, during the maintainance/repair of this crane and also the other crane for assisting other non-shuttle ships, one mobile rubber-tired quay side tower crane of 15 tons lifting capacity is needed.

3.4.3 Port Storage

3.4.3.1 Existing

The total gross area of a series of first line transit sheds located in 4 buildings along the face of the quay is approximately 8.812 m2. Under the Inpres 4/85, these sheds are now operated by PPC II branch Palembang. However, the allocation of cargo in the sheds is determined not only by this company, but also by other cargo-related company. Cargoes are generally stored by vessels but they are not subdivided by consignment. With the exception of cargo in large crate, the average stacking height is about 2 metres. The cargo is staked by hand or with forklift.

The total area of open storage (yard) for non-container cargo is approximately 8.178 m2, which located at three areas. The first is along the main wharf in the front of shed A, B, D and E. The second is behind shed H, and the third is alongside the shed I. The primary cargoes placed in the open storage are cargo in drums, tanks, machinery, iron and steel products, vehicles, and dangerous commodities. For the container operation, the paving of area of approximately 27.000 m2 behind international quay is expected to be completed in the end of 1988.

3.4.3.2 Future

(1) Non Container Cargo (Space Requirement)

The gross floor area (A) of shed or yard required for non-container cargo can be estimated as follows:

A = q * a1 * a2 * a3 [m2]

where:

q = the maximum quantity of cargo in storage found from simulation run of 2 year (1990 and 1995) and 1/2 year (2005) (table D.1).

a1 = the occupied area in m2 per ton of cargo.

a2 = an allowance for additional storage space for specific cargo, damaged cargo etc.

a3 = an allowance for space not used for stacking, such as: alley-ways, administration offices in the shed, space for sorting and stripping, space for hoisting equipment, etc.

These factors are varied;

	a1	a2	a3
<u>In Shed</u>, an average stacking height of 2 m, and storage factor of 1.67 m3 per ton	0.835	1.2	1.4
<u>In Yard</u>, trucks are allowed to load at the storage area	0.835	1.2	1.5

Using the above factors and formula, the future required storage area for non-container cargo:

	Shed			Yard		(m2)
	1990	1995	2005	1990	1995	2005
International Cargo	2355	2610	4295	4810	6975	12940
Domestic Cargo	2695	3075	4210	2195	2465	4015

Conclusions:

1. the existing shed and yard located at domestic subterminal is sufficient to accomodate the domestic NCC storage facilities requirement up to 2005. Thus no expansion of these storage facilities is necessary.

2. For the international NCC may need additional storage facilities by 1995. However, this depends the layout arrangement in the next chapter.

(2) <u>Container Operation Area</u>

The total size of the container storage area (A) is mainly determined by the following factors:

- number of TEU's to be handled (see chapter II)

- the type of container handling equipment used (see Annex C2)
- the average time containers stay in storage or dwelltime (DT) (see Chapter II).

The general formula:

$$A = \frac{\text{annual TEU}}{\text{365 days}} * PF * DT * LU * r$$

where:
- A peak factor (PF) of 1.50 and 1.25 for peak period are assumed for CY and CFS area requirement respectively [20].
- Land utilization (LU) per TEU depends on the container handling operation system:

SYS-TEM		LU m2/TEU CY	CFS
A	stuffing/striping in CY:		
	- loaded containers stacked 1 high in CY by heavy FLT	80	-
	- empty container, stacked 2 high in CY by heavy FLT	30	-
B	stuffing/striping in CFS:		
	- 29 m3 general cargo of one TEU stacked 1.5 m high in CFS	-	20
	- loaded and empty containers stacked 2 high in CY by heavy FLT	30	-

- A factor r represents a ratio of the average container stacking height/nominal stacking height in CY (thus only applies to CY area calculation) is as follows [22]:

nominal stacking height	r
1	1
2	0.8
3	0.7

Using the above formula and factors, the container operation area are calculated as follows:

No	SYS-TEM		Operational Area	Storage Area (m2) 1990	1995	2005
1	A	CY	Import	4700	8300	20000
			Export	1100	4500	14500
			Empty	4900	5100	4700
			Total	10.700	17.900	39.200
		CFS		-	-	-
2	B	CY	Import	not	not	9400
			Export	nec.	nec.	6800
			Empty			4700
			Total			20.900
		CFS	- shed			5900 =
			- delivery/ stuffing & stripping zone			6000
						7900
						13.900

Conclusion:

1. Up to 1995, system A is still applicable since the available container yard of 17.200 m2 is capable to cope with the area requirement.

2. Since the available area for expansion is limited in the existing operation area, thus the system B is more favourable for 2005. The CFS and its delivery/stuffing/striping zone should be built by 2005.

3.4.4 Terminal Equipment

3.4.4.1 Domestic Cargo (non-container)

As mentioned in Annex B3, the cargohandling equipments are needed for:

a. horizontal transport between quay to storage. Generally 3 FLTs are needed for 2 working shiphook (of Nusantara for example). Meanwhile the loading/discharging productivity is about 15 ton/shiphook. In 1983, only 50% of cargoes routed to the storage were carried out by forklifts of 2.5 to 3 tons capacity. Considering that cargoes shows a trend to become gradually less easy

International Institute for Hydraulic and Environmental Engineering

IHE DELFT

Mr. Budiyono
Vossendijk 177
6534 TR NIJMEGEN

Oude Delft 95
P.O. Box 3015
2601 DA Delft
The Netherlands
Tel. (015) 783401
Telex 38099 ihe
Cable Interwater

your ref. our ref. HH.JW/280 nr. 8805.10 Delft, May 18, 1988 Ext. 3445

Dear Mr. Budiyono,

In order to avoid any thought of conflicting interests the MSc. committee emphasizes that you shall include the following text on the lower side of page 2 of your report:

> This study was undertaken for educational purposes only.
>
> Althought it is based on an existing situation and on realistic data, the conclusions of the study do not necessarily correspond with the ideas and conclusions of the individual members of the MSc. -committee nor of their respective employers.

Sincerely yours,

Ir. J.H.C. Wiersma

cc. -prof.ir. H. Velsink
-ir. R. Moor

International Institute for Hydraulic and Environmental Engineering

IHE DELFT

Oude Delft 95
P.O. Box 3015
2601 DA Delft
The Netherlands
Tel. (015) 78 34 01
Telex 38099 ihe
Cable Interwater

Prof. ir H. Velsink,
Technische Universiteit,
Afdeling Civiele Techniek,
2628 CN DELFT

your ref. our ref. Delft, **26 mei 1988**
Ext.

Geachte Professor Velsink,

Betreft: BEOORDELINGSCOMMISSIE MSC.

Gaarne bevestig ik dat de samenstelling van de commissie, welke het MSc. werk van de heer Budiyono zal beoordelen, als volgt is vastgesteld:

Prof. ir H. Velsink	- voorzitter
Ir R. Moor	- lid
Ir J.H.C. Wiersma	- lid

Bijgesloten treft u aan een copie van het voorlopige reglement betreffende de beoordeling van MSc. werk, alsmede een overzicht van de door de kandidaat tijdens de cursus Waterbouwkunde behaalde resultaten.

De afstudeervoordracht zal plaatsvinden op maandag, 6 juni a.s. aanvang 15.45 uur in zaal 9.3, Oude Delft 95. De vergadering van de beoordelingscommissie zal worden gehouden na afloop van de voordracht ten kantore van Prof. van Ellen.

Ik zeg u gaarne dank voor uw bereidheid in genoemde commissie zitting te nemen.

Hoogachtend,

Prof. ir W.A. Segeren,
Direkteur

INTERNATIONAL COURSE IN HYDRAULIC ENGINEERING

1986/87

H A 3830

surname: Budiyono

other names: Doelrachman

fieldtrips: days

date, place of birth: August . 17 . 1959 . Semarang

nationality: Indonesia

degrees:

branch of study: E

diploma/~~certificate~~/~~distinction, date~~: September 1987

---

results end first term:

---

groupwork: 7

---

individual study:

---

final examination: 8

EXAMINATIONS	obligatory		optional	
	probl.	exam.	probl.	exam.
1 hydraulics 1		9		
2 sediment transportation		10		
3 statistics		8		
4 hydrology				
5 river engineering				
6 revetments				
7 soil mechanics		8		
8 principles of agronomy				
9 mathematical modeling				
10 coastal engineering		8		
11 short waves		9		
12 hydraulic scale models				
13 port planning		6		
14 ground-water flow				
15 ground-water recovery				
16 hydraulics 2				
17 engineering economy				
18				

EXERCISES

1 water balance :		11 tertiary unit design :	
2 computer programming :	8	12 drainage sluice :	
3 reservoir operation :		13 coastal engineering :	8
4 river computations :		14 Foundation Engineering :	7
5 river training :		15 Tides :	6
6 sheet pile design :	9	16 Pile Foundations :	9
7 embankment :		17 Project eval + finan. :	9
8 hydraulic scale models :		18	
9 breakwater design :	7	19	
10 irrigation and drainage layout:		20	

remarks:

Requirements for IHE Master's Degree

1. Introduction

The core of IHE activities are the 11-month courses which lead, upon successful completion of examinations, to the award of the Diploma. The principal aim of the study programmes of these courses has always been a reinforcement of the theoretical and practical knowledge of the participants in order to promote professional capabilities, especially in developing countries.

Rapid developments of science and technology made many countries aware of the need to strengthen their potential for research and application of new technologies. IHE is responding to this development by offering IHE graduates the opportunity to carry out research and studies leading to a M.Sc. degree. The diploma courses will remain unchanged and will, also in the future, constitute the backbone of the post-graduate programme of IHE. In addition they form the major requirement for the M.Sc. degree. Due to the intensity of the study programmes, research and the applications of new technologies play only a minor role in the regular 11-month courses. The development of the student's research capacity will therefore have to take place after successful completion of the regular programme.

In order to provide additional possibilities for IHE alumni to participate in the advancement of science and technology in their countries, IHE has established a special Master of Science programme for holders of the IHE diploma. Given the academic level of IHE alumni, it is possible to limit the duration of the research work and the subsequent preparation of the thesis to a period of 4-6 months.

2. Regulations

2.1. Eligibility

Former participants of IHE who possess a B.Sc. degree and have obtained a diploma of IHE with good results, preferably with Distinction, can apply by submitting a work plan for a Master's thesis.

2.2. Nature of work

The M.Sc. degree may be given for work that demonstrates an appropriate level of expertise in the selected subject area which may involve research, including laboratory work and field work or a study related to, for instance, the development and application of mathematical models or design aspects of hydraulic works. A critical assessment of the collected data and their relation to information obtained from literature forms part of the programme. The work will be presented in the form of a thesis and judged on the basis of this thesis by a committee appointed by IHE. A manuscript for publication in an international professional journal which is based on the M.Sc. research can be submitted in certain cases in place of a thesis. After approval of the thesis by the examining committee, the M.Sc. degree will be awarded to the candidate.

2.3. Contents of the thesis

The thesis should preferably consist of between 50 and 100 pages, including tables, illustrations, references, annexes, code listings and all such similar material. It should consist of:

1. Abstract or summary.

2. Contents

3. Introduction, describing the aims of the work and needs and conditions that led to its execution.

4. Background to the work, explaining the problem(s) involved, the means brought to bear on the problem and the rationale of these means.

5. Critical review of earlier work of a similar or related kind and a comparison with the work treated in the thesis. New or original aspects of the presented work should be explained.

6. Description of the work carried out, describing materials, methods and equipment used, computer codes and similar aids.

7. Results of the work, explaining clearly what has been obtained.

8. Discussion and conclusions, summarising the results obtained and describing the resulting understanding of the investigated phenomena.

9. List of References

10. Acknowledgements

11. Key words in standard format, e.g. of the American Society of Civil Engineers.

2.4. Evaluation Committee meeting

The M.Sc. candidate whose work is being evaluated, will be available for the Committee during its meetings, in order to give additional clarifications whenever required; he may also be called in at the beginning of the meeting to give a brief oral overview of the work. However, this should not be considered a form of examination.

In order to obtain a M.Sc. degree, a mark of minimally 6/10 is required. For the M.Sc. degree with distinction 8/10 is needed.

In the case the decision on the final mark would require further detailed information in order to come to a consensus, the candidate's grades obtained during his Diploma-study should be used. However, the Committee judges only the ½ year M.Sc. study as such, and not the overall performance during the 1½ years of education at IHE.

to be handled manually due to the increased average piece weight in the traditional cargo mix, the percentage of cargo needed FLT assistance will increase, about 60% in 1995 and 2005. Probably 20% of the required number of FLTs should be of 5 to 7 tons capacity so as to deal with heavy cargo.

	1990	1995	2005
Amount of cargo via storage in 1000 tons (see table D.1)	46.3	57	107.5
Percentage FLT assistance (%)	50	60	60
Number of FLTs	3	3	3
Productivity of one FLT (tons/hour)	10	10	10
Annual operational hour per FLS	775	1140	2150
Maximum annual operatinghour	2400	2400	2400

Thus 3 FLTs are sufficient to perform the horizontal transport between quay to storage of domestic cargo up to 2005. This consists of 2 FLTs of 2.5 to 3 tons capacity and one FLT of 5 to 7 tons capacity.

b. vertical movement of heavy cargo to/from trucks. This is done by FLT. One FLT of 5 to 7 tons capacity is assumed for 1995 and 2005 to perform this operation.

3.4.4.2 International Cargo (non-container)

(a) Horizontal transport from quay to shed. Considering the shed H and I are close to the quay, the horizontal transport will be carried out by FLTS (similar to the domestic cargo) 100% of the cargo destined to/from shed use the FLTS assistance.

	1990	1995	2005
Amount of cargo via shed in 1000 ton (see table D.1)	24.5	32.9	46.7
Percentage FLT assistance (%)	100	100	100
Number of FLTs	3	3	3
Productivity of one FLT (tons/hour)	10	10	10
Annual operational hour per FLT	817	1097	1557
Maximum annual operating hour	2400	2400	2400

Thus 3 FLTs are sufficient to carry out the horizontal transport quay-shed of international NCC up to 2005. This consists of 2 (two) FLTs of 2.5 to 3 tons capacity and one FLT of 5 to 7 tons capacity.
In practical operation, the above FLTs are interchangebly in use until the FLTs for horizontal transport of domestic cargo. However one extra FLT of 2.5 - 3 tons capacity is needed for maintainance/repair.

(b) Horizontal transport quay-yard.
Taking the distance between ship and yard stack into account, the tractor-trailer system is proposed to provide this operation (with FLT to load the trailers on the quay and for stacking at the storage).
A ship working 2 hooks simultaneously would have productivity of ca. 50 tons/hour. Meanwhile, the productivity of a tractor per hour is about 125 ton/hour, considering 6 minutes of round-trip cycle and 15 tons of trailer capacity. Furthermore, the productivity of a FLT is about 30 ton/hour. That one ship would likely require one tractor, 4 trailers and 2 FLTs (one FLT of 2.5 to 3 tons capacity and one FLT of 5 to 7 tons capacity. One extra tractor and two trailers are needed for maintanance/repair. The number of operating hours of tractor and FLT would be:

	1990	1995	2005
Amount of cargo via yard (1000 tons)	34.4	51.3	96.6
Tractor (hrs/year)	283	410	773
FLT (hrs/year)	295	428	805

(c) At delivery side of storage area, forklift trucks are needed for loading and unloading trucks.
Considering the operational hours for delivery and

reception of cargo is 300 days per year at 8 hours per day.

	1990	1995	2005
Amount of cargo via shed and yard (1000 tons)	59.9	84.2	143.3
Rate of delivery ton/hour	25	35	60
Number of FLT (productivity of 15 tons/hr), consists of:	2	3	4
- 2.5 to 3 tons capacity	1	2	3
- 5 to 7 tons capacity	1	1	1

3.4.4.3 Container Handling Equipment

The existing container handling equipment consists of one FLT of 35 tons lifting capacity, 2 units of tractor (head truck), and 6 unit of trailers (45 tons capacity). For the future requirement is calculated below:

1. FLT (Heavy Forklift)

		1990	1995	2005
. Container throughput (TEU/year)	=	4500	8000	19000
. Time required for the ship to CY operation (in hours) $\frac{\frac{TEU/year}{TEU/cycle} * 6\ min/cycle+50\%}{60\ min/hours}$ (50% added as compensation for cycle of less than 2 TEU)	=	337.5	600	1425
. Time required for CFS To CY operation (in hours) $\frac{\frac{TEU/year}{TEU/cycle} * 6\ min/cycle}{60\ min/hours}$	=	225	400	950
Total time		562.5	1000	2375

Based upon 2500 hour as a maximum annual operational hours for each piece of equipment, thus one heavy FLT is sufficient for container handling up to 2005. However, the FLT annual operating hour is close to the maximum value, therefore, stacking operation can be carried out with assistance of mobile yard crane. In case of heavy FLT breakdown, the tractor-trailer together with mobile yard crane replace the operation. (During normal situation, these tractor-trailers are used for horizontal transport of international non-container cargo).

2. Tractor

For the ship - CY operation with both the ship's crane and mobile yard crane assistance (I) and th CFS-CY operation (II) in hours.

			1990	1995	2005
(I)=TEU/year * 6 min/cycle 2 TEU/cycle 60 min/hour	+ 50%	=	337.5	600	1425
(II)= TEU/year * 4 min/cycle 2 TEU/cycle 60 min/hour		=	150	265	630
	Total (hrs)		487.5	865	2055

Thus one tractor will be sufficient to handle container flow up to 2005. However one extra tractor is needed for maintainance/repair.

3. Trailer

The number of terminal trailer for container handling operation are estimated as follows (capacity 25-35 ton):

	1990	1995	2005
between ship and CY	5	5	5
at CFS door	-	-	8
preparing for CFS	-	-	8
maintanance/repair	1	1	3
	6	6	24

4. Forklift for stuffing/stripping

FLT's of maximum 3 tons lifting capacity are used for stuffing/stripping. One FLT is required for every 2 TEU's handled daily. Based on 300 working days per year and one shift operation of 8 hours per day (thus 2400 operating hours per year per FLT), the number of FLT's required will be:

	1990	1995	2005
throughput (TEU/year)	4500	8000	14000
FLT's = TEU/year x 1 / 2 * 300	8	14	32
Maintanance/repair	1	2	4
	9	16	36

5. Mobile yard crane

In case of heavy FLT breakdown, stacking operation in yard is replaced by one mobile yard crane of 25 tons lifting capacity.

3.4.5 Summary

Table 3.4 presents the summarized physical requirement in 1990, 1995 and 2005.

Table 3.8 Summary of Facilities Requirement of MPT

		Existing	Requirement in					
		1986	1990		1995		2005	
			ICS	DCS	ICS	DCS	ICS	DCS
I.	CARGO FLOWS							
	- Container (TEU)		4500	-	8000	-	19000	-
	- NCC - Int. Cargo (tons)							
	- Dom. Cargo (tons)							
II	INFRASTRUCTURE							
	1. Quay (m)	360 + 375	360	375	360	375	360	375
	2. Shed - NCC shed (m2)	8812	2350	2700	2600	3075	4300	4200
	- CFS (m2)	-	-	-	-	-	6.000	-
	3. Yard - NCC (m2)	8200	4800	2200	7000	2500	13.000	4000
	Container (m2)	10000	10.700	-	18.000	-	21.000	-
	Access to CFS	-	-	-	-	-	7700	-
	Access to NCC shed							
	Other space (15%)	1						
III	EQUIPMENT (unit)							
	1. Mobile tower crane 35 T	1	1	-	1	-	1	-
	2. Mobile tower crane 7.5 T - 18T	4 *)	3	-	3	-	3	-
	3. Mobile yard crane 25 T	1	1	-	1	-	1	-
	4. Heavy Forklift 35 T	1	1	-	1	-	1	-
	5. Tugmaster (tracktor) 25-35 T	2	2		2		2	
	6. Trailer (chasis) 25-35 T	6	6	-	6	-	24	-
	7. Forklift truck 3,5 T	14 (2 to 5 tons)	14	2	22	2	43	2
	8. Forklift truck 5-7 T	6 (7 to 15 tons)	3	2	3	2	3	2

ICS = International Cargo Subterminal
DCS = Domestic Cargo Subterminal
*) there are 4 cranes of 15/18 tons capacity

b. Independency investigation
for Y1, Y2 Y6:

$s^2 = 26.04$

$S^2 = 7.98$

$$K = \frac{s^2}{S^2} = 3.26$$

From table 3.2 (with P = 0.05):
k = 1.0682
kl = 3.7318
Thus k < K < kl no correlation or independent.

Finally, the R determination and independency investigation for all alternative of tR is sumarized below:

Table 3.4. Summary of TE calculation.

No	tR months	R	TE years	correlation					
				s2	S2	K	k	kl	+ pos. - neg. o no
1	12	6	6	26.04	7.98	3.26	1.07	3.72	0
2	6	8	4	24.76	10.34	2.39	1.12	3.45	0
3	3	13	3 1/4	25.97	19.34	1.34	1.25	3.08	0
4	2	34	5 2/3	156.70	58.31	2.69	1.47	2.67	-

The relationship between tR and TE is plotted in the figure 3.5.

Thus, the shortest TE = 3 1/4 year, achieved by 13 replications of 3 months.

However, from the experience, the 3 1/4 year simulation would take more than 2.5 hours computing time. For the sake of practice, therefore TE will be taken 2 years (8 replications of 3 months).
Finally, the simulation time consists of To = 3 months, and TE = 2 years.

Note:

For R = 8 and tr = 3 months, and convidence level of 90%; the accuracy level can be calculated as follows:

See table of BOR (tr = 3 months)

BOR = 43.72
S = 5.23

a > 7 %

Thus the accuracy level is 7%.

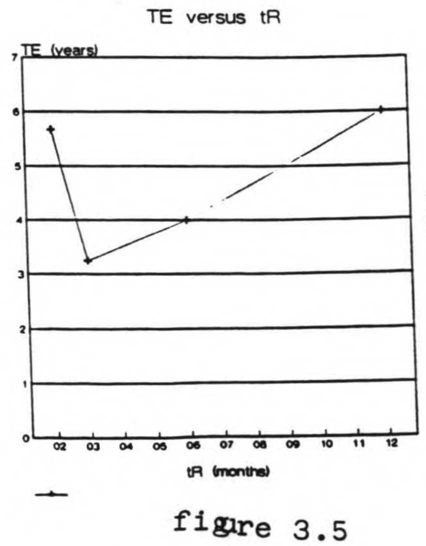


figure 3.5

chapter IV
TERMINAL LAYOUT PREPARATION

4.1 General

4.2 Masterplan Layout Alternatives

4.3 International NCC area

4.4 Container operation area

4.5 Service Craft Area

4.6 Masterplan Layout

4.7 Cost Estimate

chapter IV
TERMINAL LAYOUT PREPARATION

4.1 General

The objective of the terminal layout analysis is to develop the physical layout of Main Public Terminal within the time span of forecasting. In other words, it is to produce the 1990 terminal layout, the 1995 terminal layout and the 2005 terminal layout. The last two are commonly called the masterplan layout, for medium-term development and long-term development respectively. The layout planning in this report will emphasizes to those related to the long-term masterplan layout.

Terminal layout planning is a very important aspect in the overall port plannng. Since the physical layout of a terminal has an influence to the method and productivity of cargo handling through that terminal. But on the hand, the material handling has to deal with the physical layout of a terminal. This interdependent relationship between these two aspects implies that the layout depends on the material and moves of handling, and the selection of handling method depends upon the layout. The basic fundamental of every layout planning project are: relationship, space, and adjustment [Richard Muller, 1984]. That is, the relationship indicate the relative closeness desired between things; the space establishes the amount, kind and configuration of space for each thing; and the adjustment involves the arrangement of this space to satisfy the closeness relationship and space requirement. Thus the problem is to adjust the space to honor relationship[10]

Since only minor expansion and modification of the existing facilities will be dealt with in this report, so the problem is to rearrange the space so as to improve the layout. Only minor modification of the cargo handling method may be involved. The rearrangement of an existing facilities, area or layout (with minor expansion) is, therefore, contrained by the physical limitation of the existing area.

First step in the layout analysis is to define the objectives to be achieved and the criteria (criterion) used to evaluate the possible alternative layout. The main objectives are:

1. to provide for effective cargo handling
2. to provide for effective space utilization
3. to provide for flexibility in the layout
4. to provide for ease of future expansion.

Like most other layout analysis, only one type of criterion is considered, that is: minimizing the cost of material handling in the terminal. However, for the sake of simplicity, it will be replaced by: minimizing the volume times distance measure that cargoes travel in the terminal.

Second step is to develop several alternative layout, by considering the following factors:

1. physical facilities requirement
2. local physical constraints and conditions (including the possible area for expansion)
3. the last three objectives above.

The third step is to calculate the quantifiable criterion and to choose the optimum layout which gives the minimum quantifiable criterion.

4.2 Masterplan Layout Alternatives

As mentioned earlier, the physical local condition should be taken into consideration in developing the future alternative layout.

Figure 4.1 indicates the existing situation in 1990. There are 3 (three) categories of the port area with regard to the possibility for future expansion:

a. non-removable occupant
b. costly removable occupant
c. low cost/free removable occupant, thus become possible area for expansion.

Meanwhile, with the increasing port/terminal throughput, especially container traffic, it is likely that for the optimization the existing container facilities, the following relocation should be taken by 1995:

a. shed I, to the specified international NCC operation.
b. the PLN facilities. This space can be further paved for container yard. The construction of 25 m quay at the front of this area may not be necessary at this time.

Furthermore, the masterplan layout alternatives have to be based on the future requirement of the physical facilities. This requirement has been calculated in the previous chapter, and are formulated below:

1. For 1990 requirement, no further expansion or modification is necessary.
2. For 1995 requirement, the port development may include:
   a. filing and paving the gap at the front PNPX storage oil tank.
   b. rebuiding of 100 m existing international quay.
   c. removal of the PLN facilities and construction of quaywall and paving.
   d. rearrangement of international NCC shed. In this case, shed I is to be relocated to the specified area for international NCC operation.
   e. If points c and d above do not give sufficient space for international NCC yard (open storage), the expansion of this facility become inevitable.

Considering that the port area at the front of PNPX storage tank and east cemetry will not be optimally used for container operation, thus this area becomes favoured for the international NCC operation. The shed I will, therefore, be relocated to this area.

3. For 2005 requirement, the port development may include:
   a. construction of a new 50 * 120 m2 container Freight Station CFS
   b. development of new access road to the container operation area, and required parking area (and gates).
   c. construction of workshop, service and other supporting facilities.
   d. further expansion of the international NCC shed and yard

Based on the above development scenario, it can be concluded that the masterplan layouts alternatives will be developed as far as the international subterminal is concerned. Because the domestic subterminal does not require any expansion or modification. Beyond 2005, the relocation of shed H to the same line with other sheds may optimize this subterminal.

4.3 International NCC area

Figure 4.2, shows 3 (three) layout alternatives of the international NCC operation area. Cargoes are routed via shed or yard (and direct delivery). The layout analysis concerns with the amount of cargo and weighted-average distance the cargo travel to/from storage facilities.

Even from berthing capacity point of view, it is not necessarry to build a new international quay, but consedering that storage facilities shouldbe as near as possible with waterfront facility, therefore for alternative II,a 150 m quay at the front of proposed location of shed is planned to be built by 2005. Detailed cost comparison which include : cost of quay, benefit from saving of reducing ship time in port, and benefit gained from better cargo handling, is not carried in this study.

Alt	Storage/ Location			Area A (m2)	distance d (m)	A.d m3	weighted average d (m)
I	shed		40 * 107.5	4.300	90	-	90
	yard		85 * 155	13.000	320	-	320
II	shed		40 * 107.5	4.300	90	-	90
	yard	1	62 * 100	6.200	80	496.000	
		2	65 * 105	6.800	285	1.938.000	
				13.000		2.434.000	185
III	shed		40 * 107.5	4300	270	-	270
	yard	1	62 * 100	6200	80	496.000	
		2	68 * 100	6800	355	2.414.000	
				13.000		2.910.000	225

In 2005, 46.670 tons and 96.600 tons of international NCC to be routed via shed and yard respectively:

No		Alt I	Alt II	Alt III
1.	distance via shed (m)	90	90	270
	distance via yard (m)	320	185	225
2.	amount of cargo * distance (10 6 ton * m)			
	via shed	4.2	4.2	12.6
	via yard	30.9	17.9	21.7
	Total	35.1	22.1	34.3

Conclusion: the alternative II is the most favourable layout because it gives the minimum total of amount * distance criterion.

4.4 Container Operation Area

The container flow shown in figure c 2.2 (see Annex c2) indicates:

a. Almost all containers transported horizontally from/to apron to/from container yard.
b. Most containers transported horizontally from/to CY to/from CFS. Only some containers transported from/to CF directly to/from receiver/shipper trucks.

Although without numerical analysis as applied for international NCC, that basic flow necessitates that CFS must be located behind CY. For MPT, the location of CFS is available at the northern of existing CY. In order to generate a smooth and efficient container handling, the following further arrangement should be made:

1. The width of the apron should be at least 40m so as to have sufficient area for manoeuvring of cargo handling equipment and of transport vehicles.
2. One lonitudinal and two tranversal driveways (of 15 m wide) split the stacking area (CY) to allow equipment movement. This is also meant to separate import, export and empty container stacking area.
3. On both sides of the CFS should have a sufficiently large area for container stuffing/striping and for receiving/delivery of general cargo. The first area should be located next to the CY. The width of these area is atleast 26 metres, for manoeuvring a 15 m truck/40 ft-container combination with a 12 m turning radius.
   A special area should be also available next to CFS for direct stuffing/striping operation (and thus direct delivery/receiving as well).
4. To optimize land utilization, some inevitable broken space is used for public utilities, storing equipment and maintance shops.

4.5 Service Craft Area

Port planning requires the provision of adequate accomodation for service craft. With their limited draft requirement, there will be a little problem in term of providing adequate water depth. However, sufficient calm water berthing space and suitable docking facilities has to be made available for these essential activities [20].

The finding of consultants in 1982 was that the present three fingerpiers at the upstream end of domestic subterminal used for service craft area is generally congested. Moreover, its infrastructure is not in a proper state of maintenance [7]. Part of this congestion at this area at that time was generated by barges waiting for customs inspection. Since 1985, as a result of the implementation of inpres 4/85 (see Annex A2) ,only minor activity of custom inspection are still carried out in Indonesian ports, including port of Palembang. Thus the recommendation of the consultans regarding the allocation of custom potoon to the downstream end of international subterminal becomes not necessary.

From 1986 port data, the service craft operated in port of Palembang include: 4 (four) units tugs of 1160 to 1800 HP, 4 (four) units pilot boats of 185 to 7000 HP, 2 (two) units mooring boats of 85 HP, 1 (one) unit tug of 147 HP + 3(three) water supply barges of 80 to 100 m3, navigational aids boats ,custom boats, and navi boats. In addition sometimes the coastal guard requires a berthing facility for visiting ships. The required number of tugs, pilot boats, mooring boats, and water supply barges increase in line with the increasing of ship traffic in the future, which is almost double in 1995 and approximately triple in 2005 in comparation with 1986 ship traffic. Considering this anticipation , together with the finding of the consultants above, the arrangement of the service craft area becomes necessary. It is planned that this requrement be included in medium term development plan for 1995. Basically, the layout of this area prepared by consultants was addopted in this report.

4.6 Masterplan Layout

Further consideration in the layout preparation is that internal and external traffic should be separated. This includes:

a. reroute of public road.
b. parking space for truck should be situated preferably outside the terminal fencing.
c. gate.

Based on all consideration above, the final Masterplan Layout for 2005 has been prepared and shown in figure 4.3. This layout gives also an indication of the available area for port development beyond year 2005. The terminal layout for 1995 in figure 4.4 has been derived from that masterplan layout.

4.7 Cost Estimate

Within the envisaged port development masterplan, the following phases are planned:

Phase I, port development for 1995; which includes the following actions:
- relocate the PLN facility and provide quay and pavement on this area.
- filling and paving the gap at the front of palm oil storage tank.
- rebuilding of 100 m existing international quay.
- relocate shed I.

Phase II, port development for 2005, a number of further actions have to be taken:
- build a 50 * 120 m2 Container Freight Station.
- expand shed I with 1300 m2 additional floor area.
- provide 22,000 m2 heavy duty pavement which includes internal traffic area, parking and access road of container operation area.

- provide 20,000 m2 pavement which includes open storage, parking and access road of international NCC operational area, and rerouting of public road.

To implement the above developments, a cost estimate for civil works involved has been prepared and presented in the table 4.1.

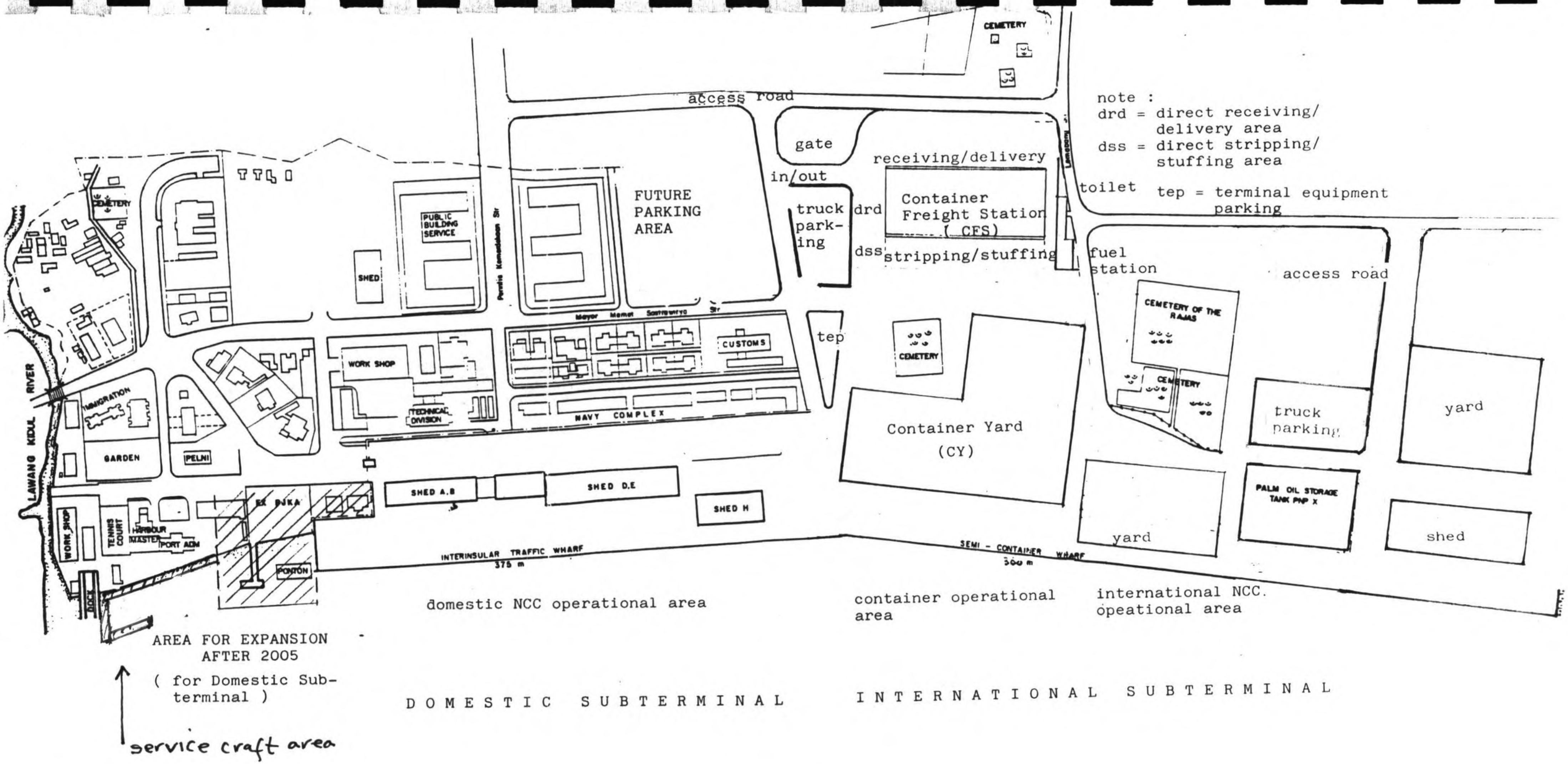


figure 4.3 THE 2005 MPT LAYOUT

Table 4.1. Cost Estimate of Civil Works

		Unit		Phase I		Phase II	
		Quan-tity	Price	Quan-tity	Price (1000 US$)	Quan-tity	Price (1000 US$)
1.	Removal of PLN building						
	- build-up area	m2	100	120	12		
	- non build-up area	m2	50	1280	64		
	- relocate pipe line etc.	m	200	2000	400		
2.	Rebuilding of Int. Quay	m	12500	100	1250		
3.	New Dom. Quay	m	7500	25	187.5		
4.	Filling and paving the gap at the from palm oil tank	m2	75	800	60		
5.	Service Craft Jetty	m	6000	150	900		
6.	Relocation of Shed I	m2	75	3000	225		
7.	Expansion of Shed I	m2	200			1300	260
8.	New Int. Quay	m	12500			150	1875
9.	Container Freight Station	m2	200			6000	1200
10.	Pavement - heavy duty	m2	45			22000	990
	- Low duty	m2	30			20000	600
11.	Ancillaries	LS			200		200
12.	Mobilization/De-	LS			50		50
13.	Contingencies (12,5%)	LS			390		615
14.	Engineering & Super-vision (15%)	LS			465		740
	TOTAL				4203.5 = 4200		6530 = 6525

Chapter V
CONCLUSIONS AND RECOMMENDATIONS

chapter V
CONCLUSIONS AND RECOMMENDATIONS

Based on the discussions and results in the previous chapters, the following conclusions and recommendation regarding port development plan are made:

1. The introduction of prearrival planning, work schedulling and performance review, together with the synchronization of different working time of all parties involved in the port operation activity are expected to increase the effectiveness of working operation. Furthermore the introduction of the multishift working system is meant to prolong the working time. These port operation improvements, which give the more effective and the longer working time, are proven to increase berthing capacity to some extent that the existing quay length is still capable to cope with the ship traffic and cargo throughout up to 2005. Since the benefit (as a saving due to decreasing of cost spent by ship in port) is much greater than the additional cost needed for the implementation of the longer working time, it is suggested that the full scale of multi-shift working system can be implemented as soon as possible. However, if that suggestion cannot be carried out immediately, the gradual improvement is recommended. In this case, the two-shift working system will have to be implemented by 2005. In summary, as far as the above port operation improvements are taken at proper time, the extention of quay, either international or domestic, will not be required until 2005. Furthermore, the outputs of simulation experementation for 2005 situation give indication which part of quay should be extended beyond 2005. Because more ships and greater percentage of ships carrying domestic cargo which berth at international quay than the ships carrying international cargo which berth at domestic quay, it can be concluded that the domestic quay will likely have to be extended first before any attempt to build a new international quay.

   However, for the better cargo handling operation the lay-outanalysis necessitates : rebuilding of 100 m internatio nal quay and costruction of 25 m new domestic quay by 1995, and costruction of 150 m international quay by 2005. Furthermore, a 150 m service craft jetty has to be provided by 1995.

2. The existing storage facilities located at the domestic subterminal has been proven to be capable to accomodate the port demand up to 2005. Thus there will be no expansion of domestic NCC storage-facilities. The capacity of the storage facilities in international subterminal, on the other hand, is sufficient to cope with port requirement up to 1995. However, masterplan layout necessitates a number actions to be included in the port development phase I (for 1995) such as: relocation of shed I, rearrangement of storage facilities and modifications of apron. To meet port requirement for

the 2005, a number further actions have to be incorporated in the port development phase II (for 2005), such as: expansion of international NCC shed and yard, and constructions of new container freight station (CFS).

3. The number of equipments required cargo handling operation is basically sufficient up to 1995 and small increase needed for 2005. However, considering that most existing equipment are operated since 1970-an, a large scale replacement by new equipments is needed. These purchasing of new equipments will have to be carried out partly by 1995 and partly by 2005.

With regard to the utilization of computer simulation modelling it turned out that this technique offers various outputs which cannot be obtained by applying other technique, such as: detailed composition of port time spent by ship in port, the influence of varied imputs (quay length, working time, number of crane, etc.), information regarding cargo in storage, etc. Even, in the application of this technique for MPT Palembang, it suggests which part of subterminal quay will have to be extended first before the other. However, this effective technique should be applied carfully, expecially if it is assisted by personal computer. The simulation program should not be developed to the extent that: (I) it can not be accomodate by the personal computer capacity, and (II) it takes a considerable computing time. For example, in order to maintain the desired outputs, the IBM PC-AT computing time of the 3/4-years simulation time of MPTSIM model for the 2005 situation is approximately 2 hours. Whereas, the simulation time of 3 1/4 year is required so as to get statistical significant outputs. In summary, in the application of simulation technique using personal computer, there is still a strict trade-off between the great detailed outputs and the limitations imposed by the personal computer capacity.

REFERENCES

1. Banks, J. and Carson II, JS. Discrete-Event System Simulation. second print. New Jersey 1984. Prentice-Hall, Inc.

2. Central Bureau of Statistics. Statistical Yearbook of Indonesia 1986. Jakarta 1987. BPS

3. Frankel, E.G. Port Planning and Development. New York 1987. Wiley. Interscience.

4. Groenveld, R. Computer Simulation and Indespensable Tool for Modern Port and Terminal Planning. Delft, 1985.

5. Groenveld, R. Service System in Port Engineering. Delft, 1984. IHE.

6. Goss, L.J. (ed.). Containerization in the Developing World 1970/1990, A appraisal of containerised traffic growth and potensial. United Kingdom, 1985. McMillan House.

7. Haskoning and PT Delta Tama Waja. Final Report: Masterplan and Feasibility Study, port of Palembang. Executive Summary, Vol I-X. Nijmegen and Jakarta, 1984.

8. ICHCA. The handling of ISO Containers in Low Throughput Situation. London, 1982.

9. Jones, L. Deep-Sea Container Ports System appraisal and Simulation Modelling. Buckinghamshire 1972. The Open University Press.

10. Kulwiec, R.A. (ed.). Material Handling Handbook. 2nd edition. New York 1984. John Wiley & Sons.

11. Payne, J.A. Introduction to Simulation, Programming Techniques and Methods of Analysis. New York 1982. McGraw-Hill Book Company.

12. Personal Prosim Textbook. Waddinxveen (The Netherlands) 1987, 1988. Siereberg & de Gans b.v.

13. Perumpel II. Port Improvement Action Plan, Jakarta 1986.

14. Perumpel II. Palembang Project. Jakarta 1986.

15. Port of Palembang. 1986 Port Statistic. Palembang 1987.

16. Rijsenbrij, J.C. and Ham, R.Th. Enter A New Gerneration Planning Tool. Cargo Systems 10 (1983) 5 (mei), p. 50-61, 7 blz., 10 afbn.

17. Soros, P. and Zador, A.T. Port Planning by Computer Simulation. Int. Dredging and Port Construction: 1977, sept., p. 24-30, 7 afbn 16 lit. opg.

18. Statistical Office of South Sumatra. South Sumatera in Figure 1985. Palembang 1986.

19. UNCTAD. Berth throughput, Systematic method for improving general cargo operation. New York, 1973.

20. UNCTAD. Port Development, A handbook for planners in Developing countries. second edition, revised and expanded. New York 1985.

21. UNCTAD. Unitization of Cargo. New York, 1970.

22. Velsink, H. Draft Lecture Notes TU Delft.

Annex A: Economy, Trade, Shipping and Port

A1. Maritime Policy

A2. Trade Policy

A3. National and Regional Economy

A4. Port Administration

A1. Maritime Policy

1. Background

Being the largest archipelago country in the world, sea transportation plays a very important role in inter-island, as well as in international trade in Indonesia. Meanwhile, the increasing volume of trade as a consequence of the grawing economy means a grawing infrastructural requirement also, i.e.: ports, vessels, acces channels etc. However, the sufficient funds needed to keep pace with that trend is not always available since the beginning of this decade (see Annex A4). Only rehabilitation programmes can be carried out. Whereas, capacity enlargement programmes are carried out only if bottleneck situations occur. In other words, an overall policy to guide maritime development was largely absent. To overcome this, the Government of Indonesia has formulated a complete restructuring of the maritime sector, including the so-called Integrated Liner System (ILS) and the Gateway concept. A brief discussion of these concepts is given below.

2. Integrated Liner System (ILS)

This system aims at an increase of efficiency, especially in domestic (inter-island) sea transportation. This will be achieved by means of the allocation of specific functions and roles to the ports and vessels. The ports which serve to domestic trade, therefore, will be reclassified into two status. The port of a regional centre becomes a trunk port, and other ports in that region become feeder ports. A regular liner service will operate between trunk ports. Feeder services to and from trunk port to their allocated feeder ports, will be done by local shipping, which will not be permitted to operate between trunk ports.

This system, therefore, will lead to a more economic routing of shipping, optimum fleet size, higher load factor, and as a result, minimum cost of interisland in Indonesia.

2. Gateway Concept

This concept aims at an increase of efficiency, especially in international sea transportation to and from Indonesia. This will be achieved by means of channelling of all international general cargo through 4 (four) selected Gateway ports, i.e.: Tanjungpriok (Jakarta), Belawan (Medan), Surabaya and Ujungpandang. The principle of this concept is a three-tiered system devised for consolidation and distribution of import and export general cargo. In the first tier, large ocean-going vessels transport cargo to and from foreign ports through one of the four gateway ports. Thus, all international general cargo will be concentrated in these four ports. Associated with each gateway port is a geographical 'hintherland'. (see figure A.1.1). In the second tier, the cargo will then be channelled to or from the so called collector ports. All collector ports are trunk ports, however not all trunk ports are collector ports. The port of Palembang is one of the collector ports of Tanjungpriok gateway port. The shipping operation between gateway port (in this study: Tanjungpriok) and its collector ports (in this study: Palembang) is called shuttle service in this concept. The third tier of this system consists of the transportation of international general cargo from the collector ports to the so-called feeder ports, and vice versa.

The implementation of this concept is expected to bring a more economic routing of international shipping, optimum fleet size, higher load factor, and as a result, minimum cost of international shipping to and from Indonesia Beside those, it will lead to the following effects: (I) more direct international shipments in larger quantities by means or larger vessels. Thus, obviating the necessity of having transhipment in Singapore, (II) increase in unitization of international cargo.

3. Port Status

According to the above systems, the general cargo ports are reclassified into 4 status, i.e.: Gateway port, collector port, (non collector) trunk port and feeder port. The hierarchy of functionally independent ports according to their status is given below.

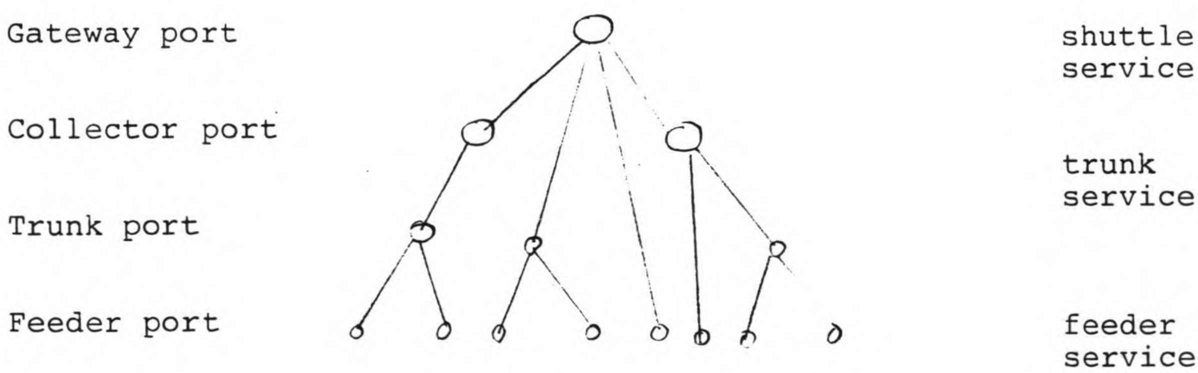
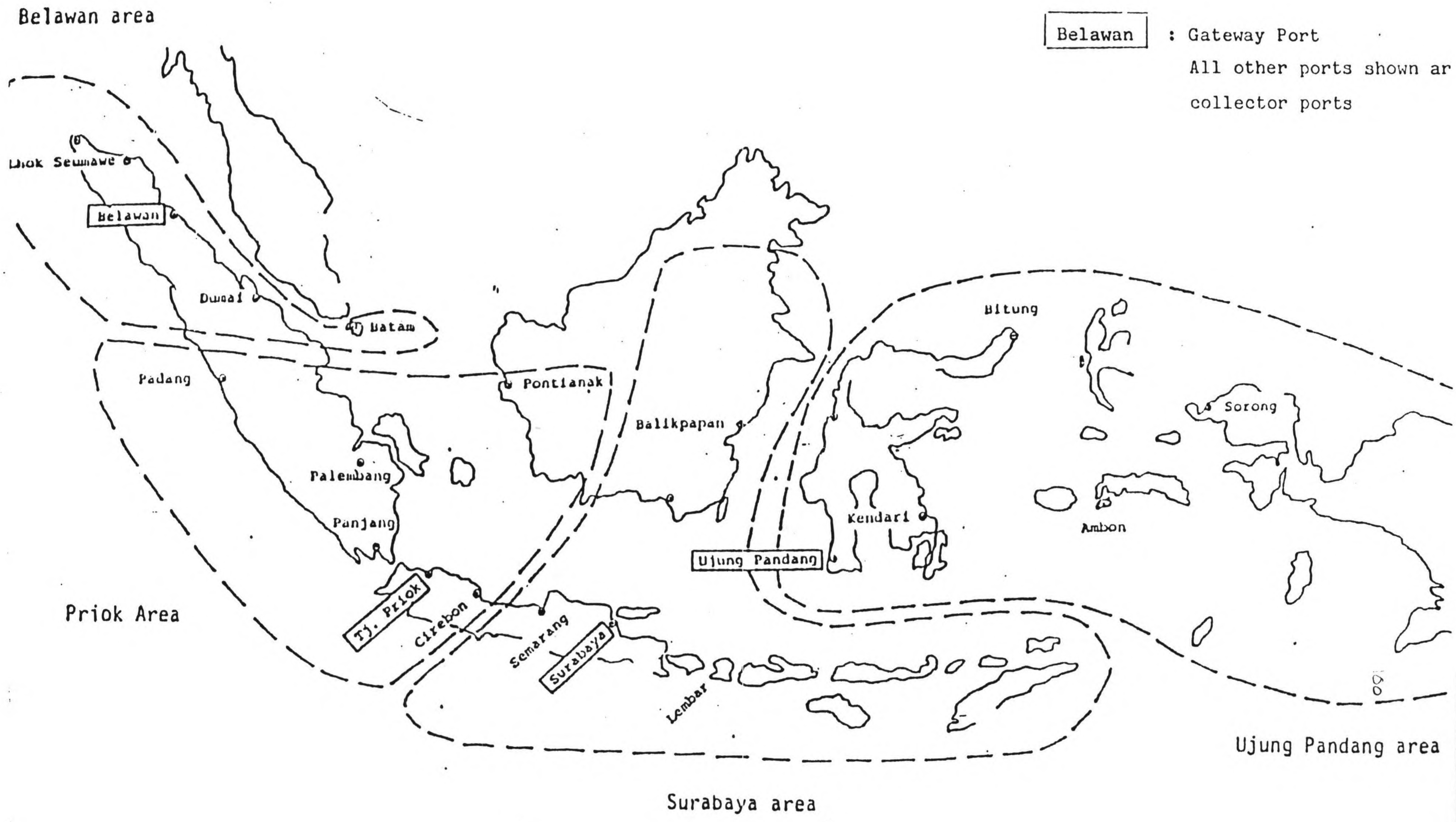


Figure A.1.1 Feeder areas of oceangoing general cargo showing the Gateway and Collector Ports



A2. Trade Policy

1. Background

Since the beginning of this decade, the world economic recession has given rise to a zero or even a negative growth rate in most developing and many developed countries. The economy growth rate of Indonesia in 1982 was only 2.2%, the same as the population growth rate, after 7.9% in the previous year. A number of short-term measures such as: currency devaluation, tax reform, project/expenses rescheduling has been taken. The devaluation of Indonesian currency was also meant to make the Indonesian export commodities more competitive in the international market. These measures have resulted in a growth rate of 4.1% and 6.1% in 1983 and 1984 respectively.

However, the world economic situation in 1985 experienced deceleration. World demand for the commodities of developing countries decreased drastically, as did their prices. The widest and deepest impact to the Indonesian economy was the oil price collapse, from 25 US $ to less than 10 US $ per barrel, within just a few months. This is because almost 55% of government revenue, and close to 70% of export revenue, came from oil and natural gas. As a result, the 1985 Indonesian economy growth rate was only 1.9%.

Apparently, the short-term measures such as devaluation or expenses rescheduling was not sufficient. The long term solution became inevitable. The decreasing revenue from one commodity has to be compensated by an other commodity, although it was not easy. The promising substitution was the manufactured product commodity. If many other countries also took similar action, this choice would have encountered strong competition in the international market. Moreover, many countries might have applied the protectionism policy. Therefore, the trade policy has to be designated to achieve: (I) domestic product capable to compete with the imported product; and (II) the export commodity become more competitive in the international market. The key to this is to improve the effectiveness so as to achieve high efficiency in any sector in the total chain of trade, including the transportation sector. This sector has always been pointed for contributing to the so-called 'high cost economy', where the expenses (thus the price) per unit output/product is high and, therefore, less competitive. In this connection, the Government of Indonesia since 1985 has issued a number of deregulation policy on trade. The most relevant legislation in port operation was the Instruction of Indonesian President No 4/85 (Inpres 4/85) regarding the policy to promote and improve the speed of flow of goods in Indonsian ports to support the economic activity.

2. Inpres 4/85

Basically, the Inpres 4/85 is containing the following measures:

(I) Institutional improvement, including:

(a) Ports reorganization.
Considering that the port organization significantly contributes to the effective and efficient of port operation, the Inpres 4/85, therefore, stipulates the reorganization of the port administration (see Annex A4).

(b) Custom procedures and documentation.
In order to avoid any delays in the cargo flow through the port due to custom procedures, the Inpres 4/85 stipulates:

- No custom inspection is necessary for export cargo, except those cargo, which upon the written instruction of the Custom and Excise Director-general, have to be examined due to there is any doubt about their export duty (additional) or regarding the possibility of a prohibited export cargo. For those export cargo, which get export certificate, the custom inspection will be carried out at their port of destination.
- For all import cargo shipment of value at more than US $ 5000, the custom inspection will be carried out at their port of origin. Whereas other import cargo can be inspected in Indonesian ports.

(c) Labour relation and regalation.
- port labours have to be reorganized.
- wages of port labour should be increased.

(II) Operation Improvement.

(a) Cargo handling activity shall be performed by stevedoring company.

(b) Cargo handling activity is carried in 3 (three) shifts:
shift I : 08.00 - 16.00
II : 16.00 - 24.00
III: 24.00 - 08.00

(III) Others:

(a) Port tariffs should be adjusted (Mostly lowered)

(b) interinsular freight will be regulated

(c) Many regulations regarding interinsular fiscal certificate, levies of the harbour-master activity (PUK), general agent certificate (SKU), standard price for import cargo (HPI) and certificate on ship's cargo (Model 5B) have been revoked. This deregulation measure aims at the ease of shipping procedures.

(d) For any foreign shipping lines which has appointed the Indonesian shipping line as its agent:

- their ships can call at any seaports (not necessarily the gateway ports, thus not in conformity with the Gateway concept).
- their ships can carry any commodity without any volume limation.

A3. National and Hinterland Economy

1. National Economy

World Bank report showed that the Gross National Product (GNP) of Indonesia in 1983 was about 86.9 billions US $; at which the growth rate during 1973 up to 1983 was 6.8% per year. The GNP comprixe of Gross Domestic Product (GDP) and net factor income. The GDP measures the value of final goods and services produced by a country's domestic economy. The share of agricultural in the Indonesian GDP is the largest, amounting to 23.58 percent (in 1985). Meanwhile, the percentage contribution of mining & quarrying, trade and manufacturing industrial sectors were, respectively 16.2, 15.4, and 13.5 percent. Furthermore, construction and transport respectively contributed about 5.3 and 6.5 percent. As mentioned in the Annex A2, the economy growth rate of Indonesia in 1981 up to 1985 were respectively 7.9%, 2.2%, 4.1%, 6.1% and 1.9%.

The unfavourable situation of world economy mentioned in the Annex A2, will certainly influence the Indonesian economy growth rate. Based on this fact, and the assumption that Indonesia succeeds to overcome the internal economic obstacle, the growth rate of Indonesian economy during next decade will be low. That is, it is estimated about 3-5% per year during the first 5 years, and over 5% per year during the second five years.

2. Hinterland Economy

The hinterland boundaries of a port, theoretically, varies for different commodities and for different origins/destinations. In this study, however, the finding of the consultant has been adopted, that in general, the hinterland boundaries approximately coincide with the provincial border of South Sumatra province. This covers an area of about km2.

The total population of South Sumatra in 1985 was about 5.5 millions, at which the population growth rate during 1971 up to 1985 was 3.36% per year. This high rate was also due to the successfull transmigration programma. Most people (69.3% are engaged in agricultural activities producing rubber (small holder plantations), coffee, pepper and food crops. About 15% of population are involved in trading and services, while 5.5% are active in industries as well as mining.
Based on the assumptions that the future transmigration programme in this region will be less priority than other region, and the gradual effect of the Family programma, the annual population growth rate is expected to decrease gradually. That is, about 3.0% during next decade, and about

2.5% afterward. These lead to the total population of about 7.4 millions in 1995 and of about 9.4 millions in 2005.

The 1984 Gross Regional Domestic Product (GRDP) of South Sumatra at current price was about 3.3 trillions rupias. The contribution of agricultural, mining, manufacturing industries, trade, construction, transportation, public administration and other sector were respectively 16.56; 16.37, 25.27, 3.73, 4.65, 4.31, and 5.19%. The average annual growth rate of GRDP during 1979 up to 1984 was 12%. Except for mining sector, other sectors increased. It can be added, that the contribution of agricultural and mining sectors decreased, while the contribution of the manufacturing industries and service sectors increased significantly. It means that the later is expected to be more growing and to hold a greater role in the future economy.

In the agricultural sector, the development plans include extension and intensification of agricultural area, mainly for rice and foods crops. Millions hectares of uncultivated lands can be utilized for farming and plantation. Swampy can be reclaimed. Medium and small irrigation scheme will be developed. Small horder plantation of rubber, coffee and coconut tree will be encouraged. Cattle breeding by people will be developed with government aids.

Coal mining in Bukit Asam for electrical power plant in Suralaya (West Java) and Bukit Asam itself will continue. The coal resources at Bukit Asam is estimated 200 millions tons, and at other area in South Sumatra is approximately 10.000 millions tons of coals with lower quality. The other minings (and quarrying) consist of oil, gas, tin, iron sand, clay limestone exploitations, etc.

The annual growth rate of manufacturing industries during 1979-1984 was very impressive, that is an average of 8.19%. Furthermore, the establishment is this sector has risen 34.26% from 1983 to 1984. In addition, a cement plant in Bataruja with capacity of 500.000 tons per year will be developed.

The transportation network such as roads, bridge, railways, and river transportation will be improved, upgrade, and developed in line with the economic activity.

In summary, based on the potensial regional and the previous growth rate of GR DP, the prospect of South Sumatra seems bright. Further economic growth rate is expected to take place.

A4. Port Administration

1. General

For administrative purposes, ports in Indonesia are administered either in group or individually; that is:

(1) Group of ports under the supervision of Maritime Districts. The whole of Indonesia is divided into 9 districts. Each maritime-district administers a group of ports within its juridiction. These ports are generally small ports and are not self sufficient, therefore the Central Government bears all cost.

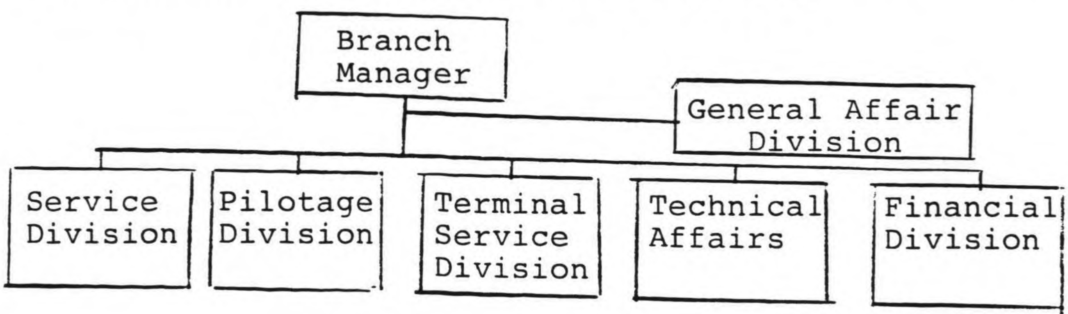
(2) Group of ports under the supervision of state-owned Public Port Corporation. Since 1983, these ports have been re-organized and grouped into 4 regional, namely:
- PPC I, with head office in Medan, administers ports in the regional of western part of Indonesia.
- PPC II, with head office in Jakarta, administers ports in the regional of western midle part of Indonesia.
- PPC III, with head office in Surabaya, administers ports in the regional of eastern midle part of Indonesia.
- PPC IV, with head part office in Ujung Pandang, administers ports in the regional of eastern part of Indonesia.

  Main Public Terminal, Sailing Vessel Terminal, and mid-river dolphins are operated by PPC II branch Palembang.

(3) Special ports, are those which deal with special cargo, e.g. petroleum, liquified gas, fertilizer, etc. owned and operated by the company concerned.
The Pertamina's oil jetties at Sungai-Gerong and Plaju, the Pusri's fertilizer wharf are example of these ports.

2. Public Port Corporation II, branch Palembang

The organization structure of this, is based on the Government regulation No 11 and 15, year 1983, in conjunction with the Government Regulation No 5/1985.



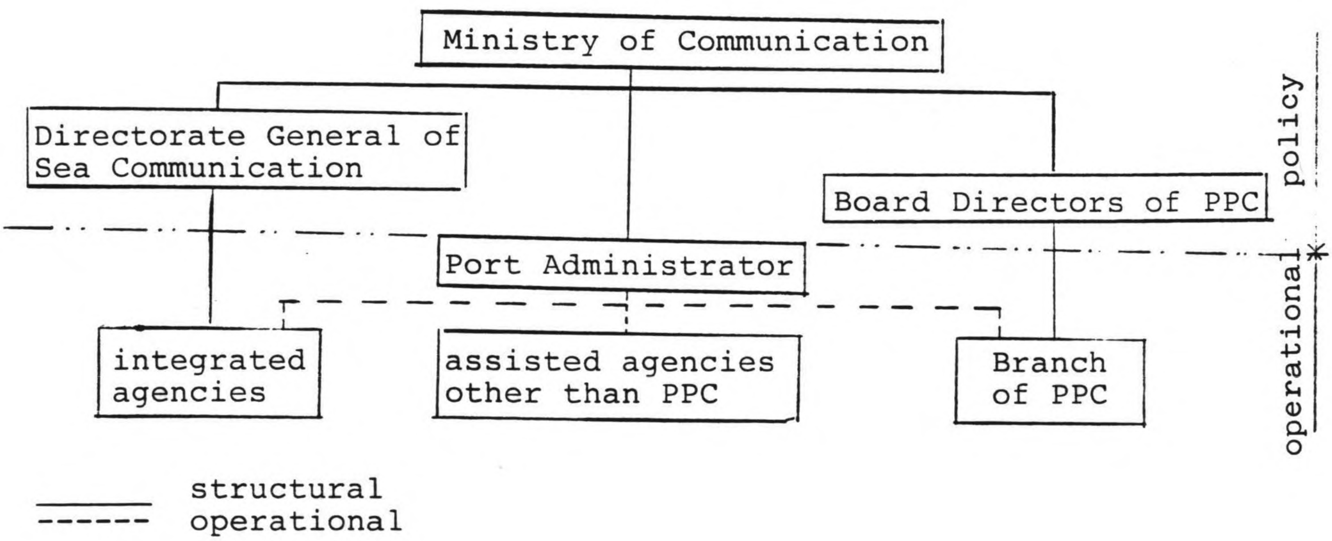
3. Port Administrater Office

Under the Indonesian Presidential Instruction No 4/1985, the Port Administrator Office is port-operation Coordinator of the following integrated and assisted agencies in the port:

(a) Integrated Agencies:
   1. Harbour Master
   2. Navigational Aids office
   3. Sea Traffic Office
   4. Sea and Coast Guards.

(b) Assisted Agencies:
   1. Brach of PPC
   2. Custom
   3. Immigration
   4. Port Health Centre
   5. (Livestock & Plant) Quarantine Office
   6. Port Police.

4. Schematic Organizational Structure of Governmental Port-related Offices :



Annex B: DATA ANALYSIS

B1. CARGO THROUGHPUT

B2. SHIP DATA

B3. CARGO HANDLING OPERATION

Bl. CARGO THROUGHPUT

Table Bl.1 shows the actual 1979/1986 cargo throughput of Palembang port, exclude Pertamina's jetty. The first 4 figures (year 1979/1982) are adopted from the consultant report. Whereas the last 4 figures (year 1983/1986) are analysed based upon the data gather ed from Port Administration. The similar problem faced by consultant are also present in this analysis, such as:

(I) most cargo figures are in manifest ton (metric ton or m3, whatever gives the highest revenue), and

(II) the miscellaneous cargoes are sometimes unproportionally large in quantity.

To overcome those problem, the consultant's solution are applied, that is:

(I) substitution/translation into metric ton unit. The consultant clarified that normally metric ton unit cargo given while m3 unit mostly concern the shipment of timer commodities. Therefore a conversion factor of 0.7 is only applied for timber commodities.

(II) the disaggregation of the large miscellaneous - undesignate - quantities. The extrapolation (or estimate) are made based upon the percentage level of division in the consultant report. This disaggregation is also in accordance with the conversion from port grouping to the standart (ISTS) commodity classification.

Furthermore, the consultant's finding regarding the physical appearance of each commodity is also indicated in table Bl.1.

With regard to the origin and destination of cargo, the 1986 data has been used. Although the O/D of each commodity is not available, the table Bl.2 which gives the general view of the O/D separated for international and domestic cargo, is nevertheless useful.

The relevant informations in accordance with the study area of this report are those which concern cargo throughput of Main Public Terminal. However there are two problems inherent in the port statistic:

(I) cargoes combined on one manifest, but handled at different location/terminal are not recorded separately.

(II) cargoes handled trhough quay are sometime not separated to barge/midstream operation.

Therefore, the finding of consultant with regard to the commodity breakdown by cargo handling facility in 1982 will still be useful (see table Bl.3). Furthermore, the other consultant's finding regarding cargo flow for Palembang over public facilities by commodity in 1982 and shiptype partipation in 1982 is also valuable for the traffic forecasting (see table Bl.4).

Finally, the cargo throughput of Main Public Terminal and the container traffic are given in the table Bl.5.

Table B1.1. Actual 1979/86 Cargo Throughput of Palembang by Commodity (in 1000 metric tons)

	International Cargo															
Commodities	Inward								Outward							
	79	80	81	82	83	84	85	86	79	80	81	82	83	84	85	86
fertilizer	-	7	-	19	22	1.5	8.5	1	127	54	26	69	202.5	13	193	414
cement	-	8.5	11	9.5	17	-	1	-	-	-	-	-	-	-	-	-
timber	-	3	2	2	-	-	-	-	580	569	285	196.5	320	342.5	312	374
sugar	50	51.5	34	48.5	5	-	-	-	-	-	-	-	-	-	-	-
copra	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
rubber	5	4	8	6	6	6	5	6	143	145	134	110	144.5	152	165	168
rice	80.5	126.5	34	8.5	41	13.5	3.5	1	-	-	-	-	-	-	-	-
sand/stone	13	15	18	16.5	13	12	9.5	12	-	-	-	-	-	-	-	-
chemicals	5	6	7	8.5	9	14.5	10	12.5	-	-	-	-	-	-	-	-
consumer goods	11	17	20	18.5	17	16	12.5	16	-	-	-	-	-	-	-	-
non-ferro	1	2	2.5	2	1.5	3.5	2.5	2	-	-	-	-	-	-	-	-
coal	-	-	-	-	-	-	-	-	49	80	38	17.5	131.5	143.5	134.5	64.5
salt	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
animal feed	-	1.5	2	2	2	2	2	2	10	12	9	6	2.5	3	7	3
wheat fluor	0.5	4	2	-	-	-	-	-	-	-	-	-	-	-	-	-
maize	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
capital goods	9	11	12	12	12	76.5	32	15	-	-	-	-	-	-	-	-
iron/steel	6	10	12	3	6.5	14	12.5	7.5	-	-	-	-	-	-	-	-
oils/fats	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
coffee	-	-	-	-	-	-	-	-	64.5	71.5	65	60.5	55	58.5	60.5	81.5
other food prod.	13	17	18	20	24	19	17.5	16.5	8.5	9.5	7	4.5	3.5	10.5	15	18.5
livestock	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
asphalt	1	7	2	19	9	11.5	28.5	13	-	-	-	-	-	-	-	-
Subtotals	199	291	184.5	195	185	190	146	104.5	982	941	564	464	859.5	713	887	1123.5

Table B1.1. Actual 1979/86 Cargo Throughput of Palembang by Commodity (in 1000 metric tons) (continued)

Commodities	Domestic Cargo															
	Inward								Outward							
	79	80	81	82	83	84	85	86	79	80	81	82	83	84	85	86
fertilizer	12	20.5	46	17.5	31.5	21.5	49.5	48	1172	1320	1375	1278	1358	1523	1225	930.5
cement	106	78	25	18.5	20	8	3	7	0.5	3	6	17	13	9	7.5	4.5
timber	41	101	182	112	114.5	112	106	137.5	111	130	157.5	159	221	224.5	185	191.5
sugar	25	20	19	4	33	35.5	16.5	7.5	-	5	1.5	3.5	1	-	-	2.5
copra	6	3	5	2.5	3.5	2.5	3	-	-	-	-	-	-	-	-	-
rubber	0.5	1	0.5	-	-	-	0.5	-	-	-	-	-	-	-	-	-
rice	33	47.5	102.5	138	96	120.5	76	119.5	3	9	15	6	1	-	7	-
sand/stone	19	23	21	20	22.5	25	36	72.5	4	4	3	2	7.5	1.5	2	9.5
chemicals	8	9	8	8	9.5	7.5	4	5.5	4	5	5	3	6	3	3	16
consumer goods	32.5	40	36	35	32	19	23	6	6	6	5	3	7	3	3	9.5
non-ferro	10	13.5	12	12	11.5	12	15.5	18	0.5	0.5	0.5	-	1	0.5	0.5	1.5
coal	-	-	-	-	-	-	-	-	37	47.5	40	42.5	41	174.5	324	278
salt	27.5	20	34	30	31	18.5	30	33.5	0.5	0.5	0.5	-	-	-	-	-
animal feed	3.5	5.5	5	5	6	6	3	4	-	1	-	-	-	-	-	-
wheat flour	13	13.5	18	32.5	39.5	38	28	32	-	-	-	-	-	-	-	-
maize	1.5	1.5	0.5	1	1	1	0.5	-	-	-	-	-	-	-	-	-
capital goods	15	19	17	16	15	15	11	12	1	1	1	1.5	1.5	1	1	2.5
iron/steel	20.5	24.5	22	21	22.5	25.5	35.5	69.5	2	3	2	1.5	4.5	1	1.5	6
oils/fats	18	17	16	20	20	13.5	16.5	17	-	-	-	-	-	1	18.5	15.5
coffee	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
other food	36.5	41	35	33.5	33	31	21	22.5	8	10	7.5	5	20	4	4.5	22
livestock	1.5	-	1.5	3	2	2	2	2	-	-	-	-	-	-	-	-
asphalt	-	-	8	12.5	29.5	12.5	13	23.5	10.5	4.5	3	5	3	4.5	6	3
Subtotal	430	498.5	614	542	574.5	539.5	489.5	654.5	1360	1550	1622.5	1527	1685.5	1950.5	1790.5	1502

Table B1.1. Actual 1979/86 Cargo Throughput of Palembang by Commodity (in 1000 metric tons) (continued)

Sub-Total Cargo

Commodities	Inward								Outward							
	79	80	81	82	83	84	85	86	79	80	81	82	83	84	85	86
fertilizer	12	27.5	46	36.5	53.5	23	58	49	1299	1374	1401	1347	1560.5	1536	1418	1344.5
cement	106	86.5	36	38	37	8	4	7	0.5	3	6	17	13	9	7.5	4.5
timber	41	104	184	114	114.5	112	106	137.5	691	699	442.5	355.5	541	567	497	565.5
sugar	75	71.5	53	52.5	38	35.5	16.5	7.5	-	5	1.5	3.5	1	-	-	2.5
copra	6	3	5	2.5	3.5	2.5	3	-	-	-	-	-	-	-	-	-
rubber	5.5	5	8.5	6	6	6	5.5	6	143	145	134	110	144.5	152	165	168
rice	113.5	174	136.5	146.5	137	134	79.5	120.5	3	9	15	6	1	-	7	-
sand/stone	32	38	39	36.5	35.5	37	45.5	74.5	4	4	3	2	7.5	1.5	2	9.5
chemicals	13	15	15	16.5	18.5	22	14	18	4	5	5	3	6	3	3	16
consumer goods	43.5	57	56	53.5	50	48	31.5	39	6	6	5	3	7	3	3	9.5
non-ferro	11	15.5	14.5	14	13	15.5	18	20	0.5	0.5	0.5	-	1	0.5	0.5	1.5
coal	-	-	-	-	-	-	-	-	86	127.5	78	60	172.5	318	458.5	342.5
salt	27.5	20	34	30	31	18.5	30	33.5	0.5	0.5	0.5	-	-	-	-	-
animal feed	3.5	7	7	7	8	8	5	6	10	13	9	6	2.5	3	7	3
wheat flour	13.5	17.5	20	32.5	39.5	38	28	32	-	-	-	-	-	-	-	-
maize	1.5	1.5	0.5	1	1	1	0.5	-	-	-	-	-	-	-	-	-
capital goods	24	30	29	28	27	91.5	43	27	1	1	1	1.5	1.5	1	1	2.5
iron/steel	26.5	34.5	34	24	29	39.5	38	77	2	3	2	1.5	4.5	1	1.5	6
oils/fats	18	17	16	20	20	13.5	16.5	17	-	-	-	-	-	1	18.5	15.5
coffee	-	-	-	-	-	-	-	-	64.5	71.5	65	60.5	55	58.5	62.5	81.5
other food	39	58	53	53.5	57	50	38.5	39	16.5	19.5	14.5	9.5	23.5	14.5	19.5	40.5
livestock	1.5	-	1.5	3	2	2	2	2	-	-	-	-	-	-	-	-
asphalt	1	7	10	31.5	38.5	24	41.5	36.5	10.5	4.5	3	5	3	4.5	6	3
Subtotal	629	789.5	798.5	737	759.5	729.5	635.5	759	2342	2491	2186.5	1991	2545	2673.5	2677.5	2625.5

Table B1.1. Actual 1979/86 Cargo Throughput of Palembang by Commodity and its Physical Appearance (in 1000 metric tons) (continued)

Commodities	Total Cargo								Physical Appearance of Cargo (1982)
	79	80	81	82	83	84	85	86	
fertilizer	1311	1401.5	1447	1383.5	1614	1559	1476	1393.5	in bulk or bags of 50 kgs
cement	106.5	89.5	42	45	50	17	11.5	11.5	bags of 42.5 kgs
timber	732	803	626.5	469.5	655.5	679	603	703	sawn timber loose, plywood 2.5 m^3
sugar	75	76.5	54.5	56	39	35.5	16.5	10	bags of 100 kgs
copra	6	3	5	2.5	3.5	2.5	3	-	N.A.
rubber	148.5	150	142.5	116	150.5	158	170.5	174	30 bales of 50 kgs on pallet (1.5 tons)
rice	116.5	183	151.5	152.5	138	134	86.5	120.5	bags of 100 or 50 kgs
sand/stone	36	42	42	38.5	43	38.5	47.5	84	bulk/loose pieces
chemicals	17	20	20	19.5	24.5	25	17	34	partly drums, bulk or yerrycans
consumer goods	49.5	63	61	56.5	57	51	34.5	48.5	mostly loose cargo
non-ferro	11.5	16	15	14	14	16	18.5	21.5	in 90 ts packed together to 3.8 tons
coal	86	127.5	78	60	172.5	318	458.5	342.5	in bulk
salt	28	20.5	34.5	30	31	18.5	30	33.5	in bulk (DN Caram) or bags of 55 kgs
animal feed	13.5	20	16	13	10.5	11	12	9	bags of 45 kgs
wheat flour	13.5	17.5	20	32.5	39.5	38	28	32	bags of 22.5 kgs
maize	1.5	1.5	0.5	1	1	1	0.5	-	bags of 80 kgs
capital goods	25	31	30	29.5	28.5	92.5	44	29.5	loose cargo
iron/steel	28.5	37.5	36	25.5	33.5	40.5	39.5	83	mostly loose pieces
oils/fats	18	17	16	20	20	14.5	35	32.5	drums of 200 kgs, partly deep tanks
coffee	64.5	71.5	65	60.5	55	58.5	62.5	81.5	bags of 60 kgs
other food	55.5	77.5	67.5	63	80.5	64.5	58	79.5	tea: bags of 40 kg
livestock	1.5	-	1.5	3	2	2	2	2	-
asphalt	11.5	11.5	13	36.5	41.5	28.5	47.5	39.5	drums of 157 kgs
Grand Total	2971	3280.5	2985	2728	2204.5	3403	3313	3384.5	

Table Bl.2. Origin & Destination of International & Domestic Cargo.

Origin & Destina- of Interna- tional Cargo	Asia				%			
	Asean Singa- pore	others	Japan	Taiwan Hong- kong China	others	Europe	US	others
Inward								
1983	37.0	29.4	14.3	8.1	2.7	5.6	1.9	1.1
1984	36.5	8.2	33.8	4.1	-	15.3	1.0	1.1
1985	56.3	5.2	20.3	3.9	2.4	11.1	0.1	0.7
1986	42.7	-	22.6	9.5	-	19.4	1.0	4.8
Outward								
1983	8.9	39.8	8.2	9.0	5.1	11.4	14.1	3.5
1984	7.3	26.3	14.5	7.0	7.3	14.5	20.9	2.2
1985	10.0	24.7	18.5	16.2	5.2	10.6	13.3	1.5
1986	16.0	14.9	14.7	24.1	3.9	15.4	9.8	1.2

Origin & Destina- tion of Domestic cargo	Sumatera			Java				
	Bangka/ Beli- tung	Pan- jang	Others	Jakar- ta Merak	Sema- rang Cila- cap Sura- baya	others	Kali- mantan	others
Inward								
1984	0.9	-	6.8	39.9	18.7	11.4	21.7	1.2
1985	0.4	2.4	7.7	37.5	8.0	17.0	25.6	1.4
1986	0.7	1.9	10.4	44.3	3.7	15.9	20.6	2.5
Outward								
1984	7.8	0.7	2.5	18.1	57.3	5.1	1.3	7.2
1985	8.7	1.7	2.5	24.5	50.4	6.6	0.8	4.8
1986	9.2	4.0	2.5	32.0	46.8	2.7	1.4	1.4

Table B1.4. Cargo flows for Palembang over public facility, by commodity in 1982 (1000 metric tons)

c a r g o	Boom Baru								Midstream								total				total
	in				out				in				out								
	O.G.	RLS	Lok.	Khs.	O.G.	RLS	Lok.	Khs.	O.G.	RLS	Lok.	Khs.	O.G.	RLS	Lok.	Khs.	O.G	RLS	Lok.	Khs.	all
fertilizers	19	9.5	-	-	-	-	3	-	-	-	-	-	-	-	-	-	19	9.5	3	-	31.5
cement	9.5	6	-	-	-	-	1	-	-	-	-	-	-	-	12	-	9.5	6	13	-	28.5
sugar	28.5	-	-	-	-	-	0.5	-	20	-	-	-	-	-	-	-	48.5	-	0.5	-	49
rice	8.5	45.5	-	24	-	2	-	-	-	-	-	45	-	-	-	-	8.5	47.5	-	69	125
salt	-	5	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-	13	-	-	13
animal feed	2	-	1	-	6	-	-	-	-	1	1	-	-	-	-	-	8	1	2	-	11
wheat flour	-	2	23	-	-	-	-	-	-	-	5	-	-	-	-	-	-	2	28	-	30
coffee	-	-		-	6	-	-	-	-	-	-	-	54	-	-	-	60	-	-	-	60
consumer goods	10	7.5	4	-	-	-	-	-	8.5	8	6.5	-	-	-	1.5	-	18.5	15.5	12	-	46
non ferro	2	6	3	-	-	-	-	-	-	-	-	-	-	-	-	-	2	6	3	-	11
capital goods	4	4	1.5	-	-	-	0.5	-	8	6.5	2.5	-	-	1	-	-	12	11.5	4.5	-	28
iron/steel	-	5	13	-	-	-	-	-	3	2	-	-	-	-	-	-	3	7	13	-	23
oth. food product	5	9	10	-	-	-	0.5	-	15	4	3	-	5	1	0.5	-	25	14	14	-	53
chemicals	8.5	1.5	1.5	-	-	1	-	-	-	2	1	-	-	1	-	-	8.5	5.5	2.5	-	16.5
oils and fats	-	3	5	10	-	-	-	-	-	-	-	-	-	-	-	-	-	3	5	10	18
asphalt	19	2.5	-	-	-	-	-	-	-	7	3	-	-	1	4	-	19	10.5	7	-	36.5
timber	2	-	-	-	-	3	1.5	-	-	-	-	-	40	10	25	10	42	13	26.5	10	91.5
coal	-	-	-	-	-	-	-	-	-	-	-	-	10	-	-	17	10	-	-	17	27
copra	-	-	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5	-	0.5
rubber	6	-	-	-	6	-	-	-	-	-	-	-	104	-	-	-	116	-	-	-	116
sand/stone	4.5	4.5	11	-	-	2	2	-	12	-	-	-	-	-	-	-	16.5	6.5	13	-	36
livestock	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	3
total	128.5	111	76.5	34	18	8	9	-	66.5	38.5	22	45	213	14	43	27	426	171.5	150.5	106	854

Table B1.3. Commodity breakdown by cargo handling facility 1982 (1000 metric tons)

Cargo	Boom Baru		Prahu/Lokal		Midstream		Special		T o t a l	
	in	out	in	out	in	out	in	out	in	out
fertilizers	28.5	3	8	7	-	-	-	1,337	36.5	1,347
cement	15.5	1	12.5	4	-	12	-	-	28	17
sugar	28.5	0.5	4	3	20	-	-	-	52.5	3.5
rice	78	2	23.5	4	45	-	-	-	146.5	6
salt	5	-	4	-	8	-	13	-	30	-
animal feed	3	6	2	-	2	-	-	-	7	6
wheat flour	25	-	2.5	-	5	-	-	-	32.5	-
maize	-	-	1	-	-	-	-	-	1	-
coffee	-	6	-	-	-	54	-	-	-	60
subtotal	185.3	18.5	57.5	18	80	66	13	1,337	334	1,439.5
cons. goods	21.5	-	9	1.5	23	1.5	-	-	53.5	3
non ferro	11	-	3	-	-	-	-	-	14	-
capital goods	9.5	0.5	1.5	-	17	1	-	-	28	1.5
iron/steel	18	-	1	1.5	5	-	-	-	24	1.5
oth. food product excl. coffee	24	0.5	7.5	3	22	6.5	-	-	53.5	10
subtotal	84	1	22	6	67	9	-	-	173	16
chemicals	11.5	1	2	1	3	1	-	-	16.5	3
oils and fats	18	-	2	-	-	-	-	-	20	-
asphalt	21.5	-	-	-	10	5	-	-	31.5	5
subtotal	51	1	4	1	13	6	-	-	68	8
timber	2	4.5	-	-	-	85	112	264	114	353.5
coal	-	-	-	-	-	27	-	33	-	60
copra	0.5	-	2	-	-	-	-	-	2.5	-
rubber	6	6	-	-	-	104	-	-	6	110
sand/stone	20	4	4.5	-	12	-	-	-	36.5	4
livestock	3	-	-	-	-	-	-	-	3	-
subtotal	31.5	14.5	6.5	-	12	216	112	297	162	527.5
GRAND TOTAL	350	35	90	25	172	297	125	1,634	737	1,991

Table B 1.5. Cargo Throughput of MPT

1. General Cargo

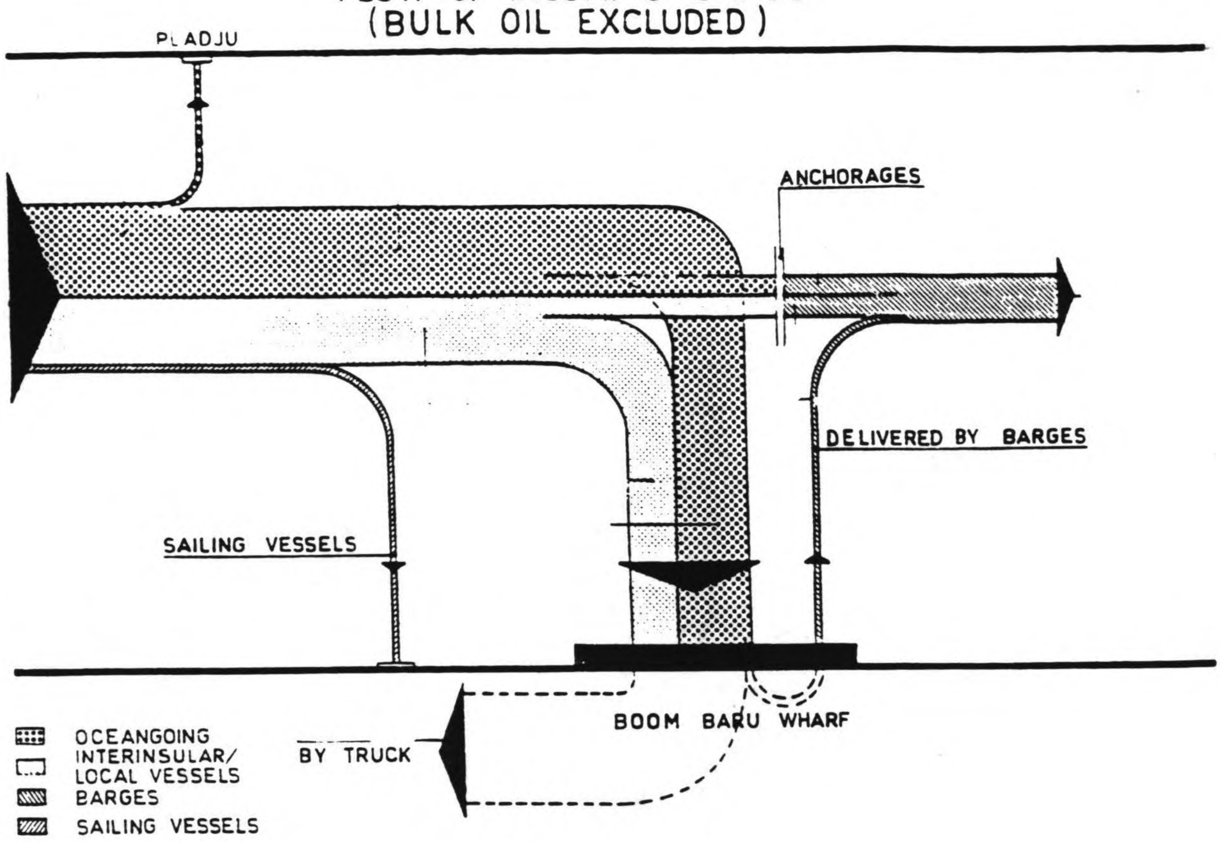
(in 1000 MT)

	International			Domestic			Total		
	Import	Export	Sub total	Inward	Outward	Sub total	In	Out	Grand total
1974/75	83	0	83	100	13	113	183	13	196
1981	132	5	137	288	37	325	420	42	462
1982	128	18.5	146.5	222	16.5	238.5	350	35	385
1983			137			267.5			404.5
1984			105.5			202			307.5
1985			89			212			301
1986	59	19	78	198	19.5	217.5	257	38.5	295.5

2. Container Traffic

Year	ton	TEU
1982	.	.
1983	.	.
1984	6.817	1.154
1985	11.169	1.624
1986	14.500	2140

FLOW OF INCOMING CARGO
(BULK OIL EXCLUDED)



FLOW OF OUTGOING CARGO
(BULK OIL EXCLUDED)

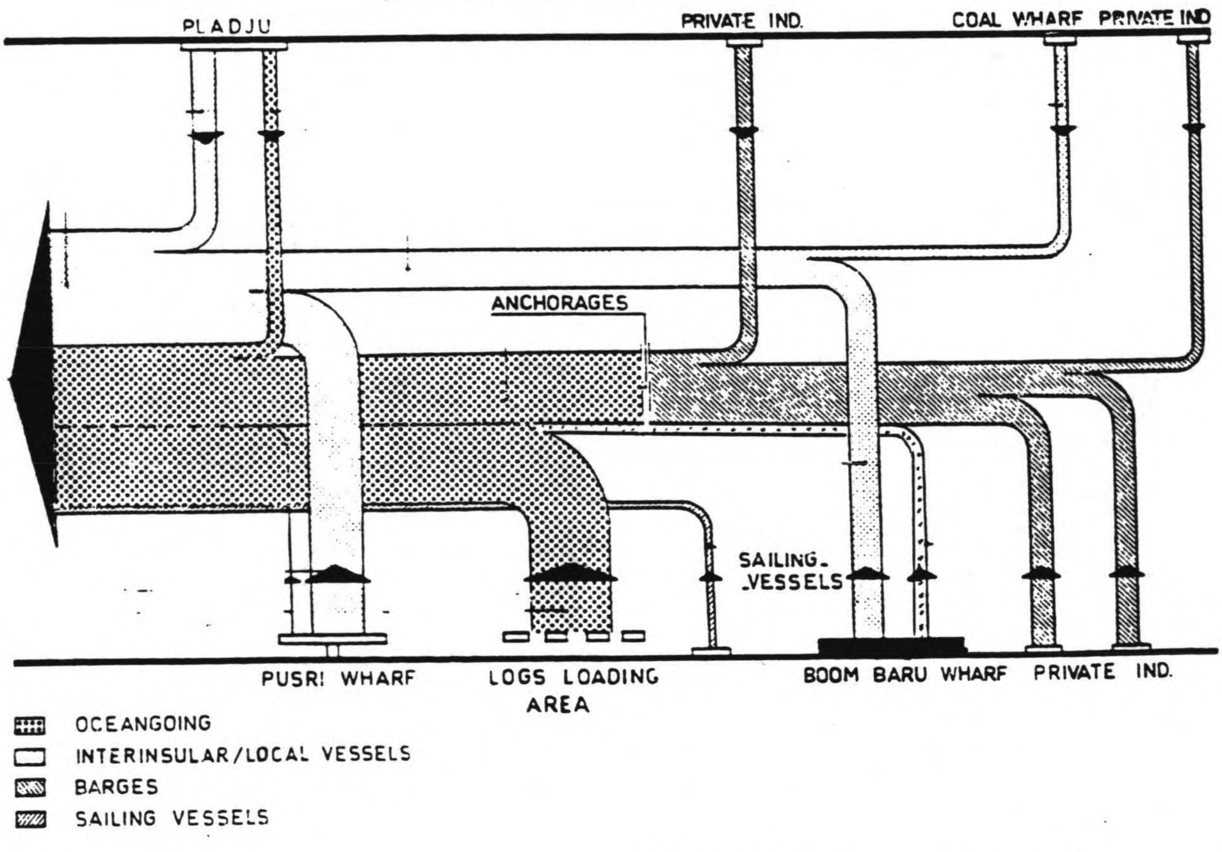


figure B1.1
THE PORT OF PALEMBANG
INCOMING AND OUTGOING CARGO FLOWS

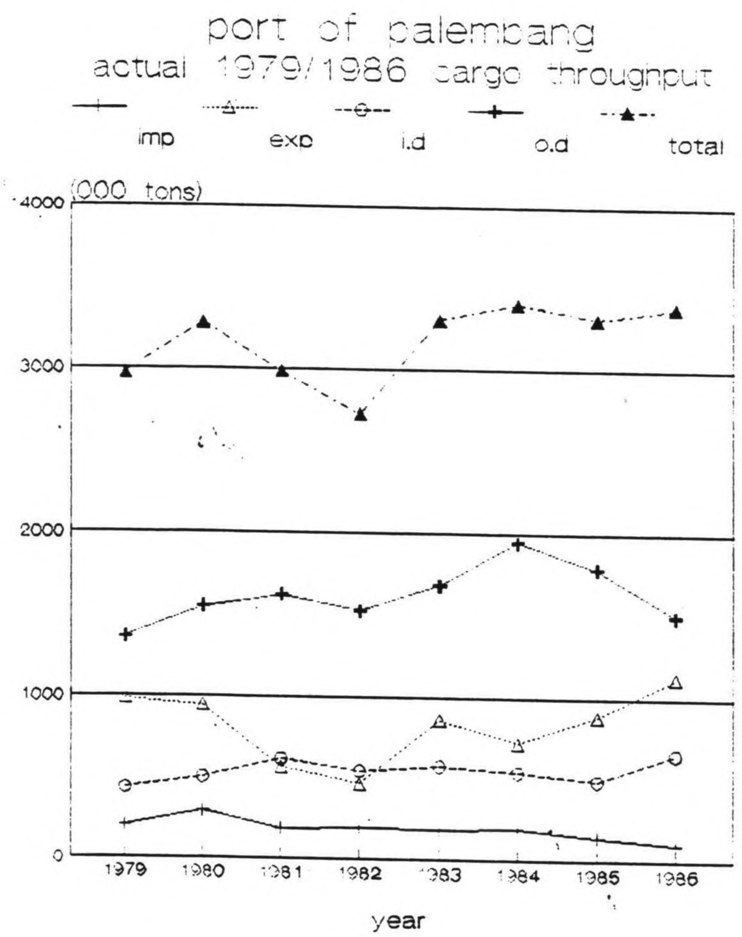
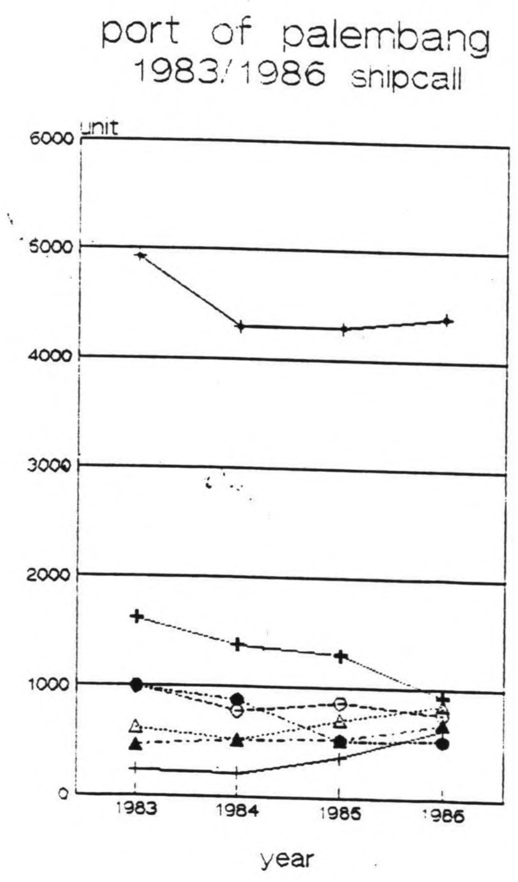
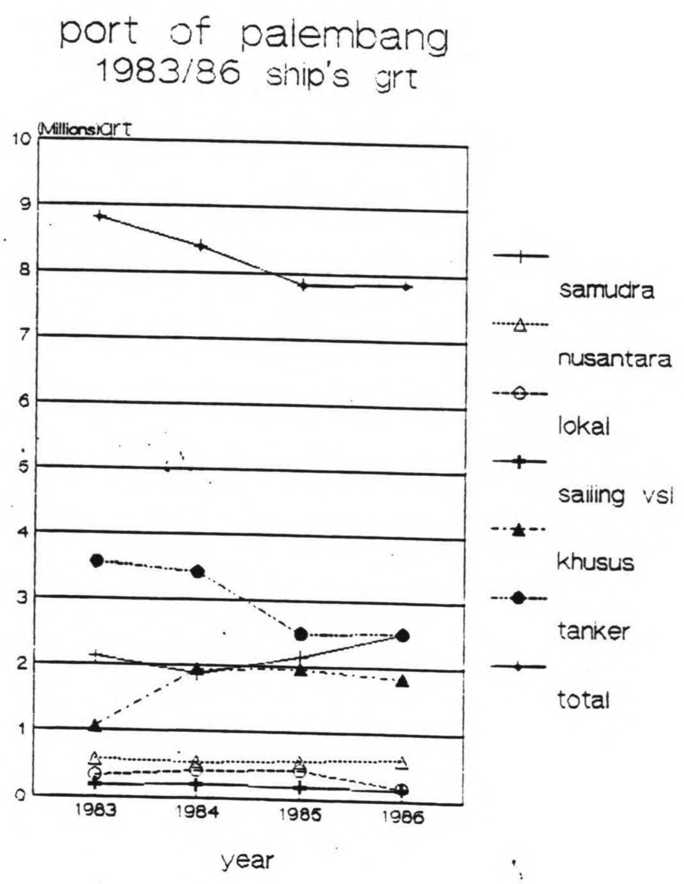


figure B1.2 Actual cargo throughput & shipcall of Palembang port.





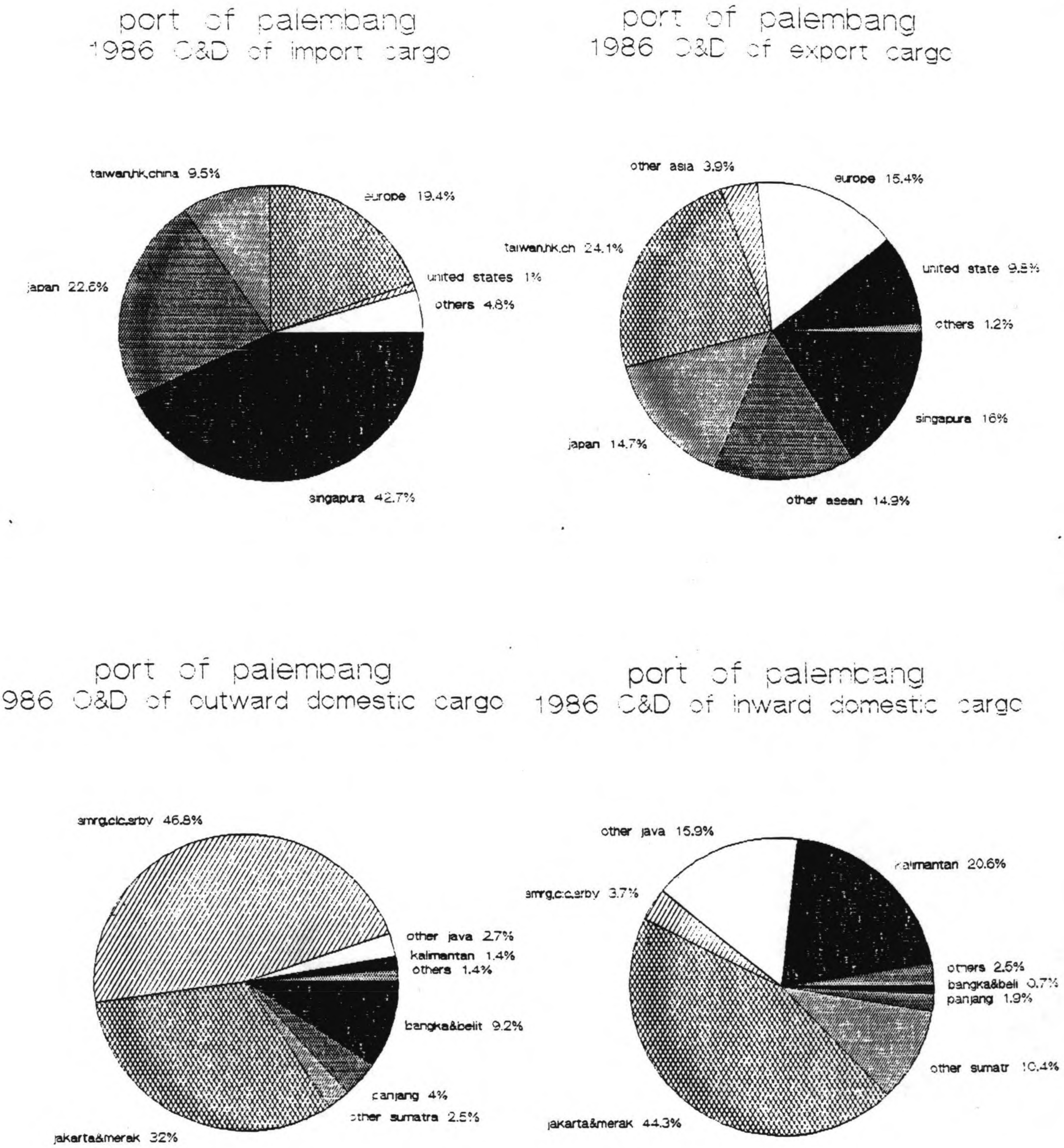


figure B1.3 Origin & Destination of international and domestic cargo through port of Palembang.

B.2 SHIP DATA

1. Ship's Arrival

The arrival pattern of Samudra, Nusantara, Lokal and Khusus vessels were analysed by Haskoning using the 1982 data[7]. Its findings were:

	k-value, and	rounded to
Samudra	1.34	1
Nusantara	1.21	1
Lokal	1.32	1
Nusantara	1.12	1

In other words, they follow the poisson distribution.

Furthermore, it was assumed that the arrival pattern of:

- Rubber barge is the poisson distribution, because of less scheduled arrival, and
- Shuttle ship is the Erlang distribution with high value of k, because of more scheduled arrival. In the Personal Prosim, for k value of more than 10, this distribution will advisably be replaced by the Normal Distribution.

2. Ship's Length

The analysis of ship's length distribution has been carried out using the 1986 STP sheet data. Unfortunately, the separate record of general cargo ships which merely called at Main Public Terminal, only gave the average size (length), not the ship's length distribution. However, the record of general cargo ship of each type which called at all loading points in the port of Palembang, concerning the number of ship's arrival of a certain size group, the maximum and minimum recorded size, has been summarized in the following table:

Size (m3)	Length (m)	Number of ship's arrival of Samudra	Nusantara	Lokal	Khusus
> 10.000	> 110	276	-	-	19
5001-10.000	80-110	73	22	-	21
1501- 5.000	50-80	199	240	13	15
501- 1.500	40-50	278	142	28	38
< 500	< 40	158	198	340	21
Minimum recorded length (m):		35	30	25	30
Maximum recorded length (m):		150	100	80	120
Average length (m):		64	44	30	60

Note: the size of ships were recorded in m3. 1GRT is equal with 2.835 m3.

Therefore, the histogram of ship's length distribution have been developed in such a way that the average length of ship (which was found from the data of ships which moored at Main Public Terminal) was maintained. This led to the following histograms shown in figure B.2.2 .

Furthermore, the ship's length distribution for rubber barge and shuttle ship (future vessels) were assumed to be uniform distribution, where:

	minimum length (m)	Maximum length (m)
Shuttle ship:	90	105
Rubber barge:	25	35

3. Ship's Cargo

The 1986 STP data sheet only gave the average value of ship's cargo per call. The 1982 data of service time gave indication that the maximum ship's cargo was not more than 6 times of the average ship's cargo. Because no other data was available, the ship's cargo distribution of Samudra, Nusantara, Lokal and Khusus have been developed based upon those available data and using the following assumption:

- the length and the amount cargo of a ship have certainly no specific relationship. In general, they may independently and randomly be defined. However, it must be considered also, there is a general relationship between length and carrying capacity of a ship. This could limit the independency to assign amount of cargo to a certain length of ship.
- from investigation, due to wide range of ship's length and cargo distribution, the length and cargo for Samudra, Nusantara, Lokal and Khusus were dependent relationship.
- the assignment of cargo quantity to a group of ship's length, range between the appropiate lowest cargo (certainly not zero) to the possible maximum cargo (carrying capacity limitation).

The rough estimate of ship's cargo distribution, were given below:

1. Samudra

Ship's length (m)	Probability (%)	Ship's cargo factor Min.	Max.
35 - 40	30	0.2	0.6
40 - 50	30	0.2	0.9
50 - 60	10	0.2	1.4
60 - 80	16	0.2	2.0
80 - 110	12	0.2	3.7
110 - 150	12	0.2	4.2

ship's cargo = Mean cargo * ship's cargo factor.
(Average)

2. Nusantara

Ship's length (m)	Probibility (%)	Ship's cargo factor Min.	Max.
30 - 40	45	0.3	0.8
40 - 50	25	0.3	1.5
50 - 60	15	0.3	2.5
60 - 70	8	0.3	2.9
70 - 80	4	0.3	3.9
80 - 100	3	0.3	5.9

3. Lokal

Ship's length (m)	Probability (%)	Ship's cargo factor Min.	Max.
25 - 30	75	0.6	1.2
30 - 40	15	0.8	1.4
40 - 50	7	1.0	2.0
50 - 80	3	1.0	3.0

4. Khusus

Ship's length (m)	Probability (%)	Ship's cargo factor Min.	Max.
30 - 40	20	0.2	0.4
40 - 50	35	0.2	1.2.
50 - 80	15	0.2	2.6
80 - 100	20	0.2	3.0
100 - 120	10	0.2	5.0

Note: Ship's cargo = Average Cargo * Ship's cargo factor.

Furthermore, for the future vessels (Rubber barge and Shuttle ship), the independent relationship between length and cargo was assumed, considering the range of length and cargo is not wide.

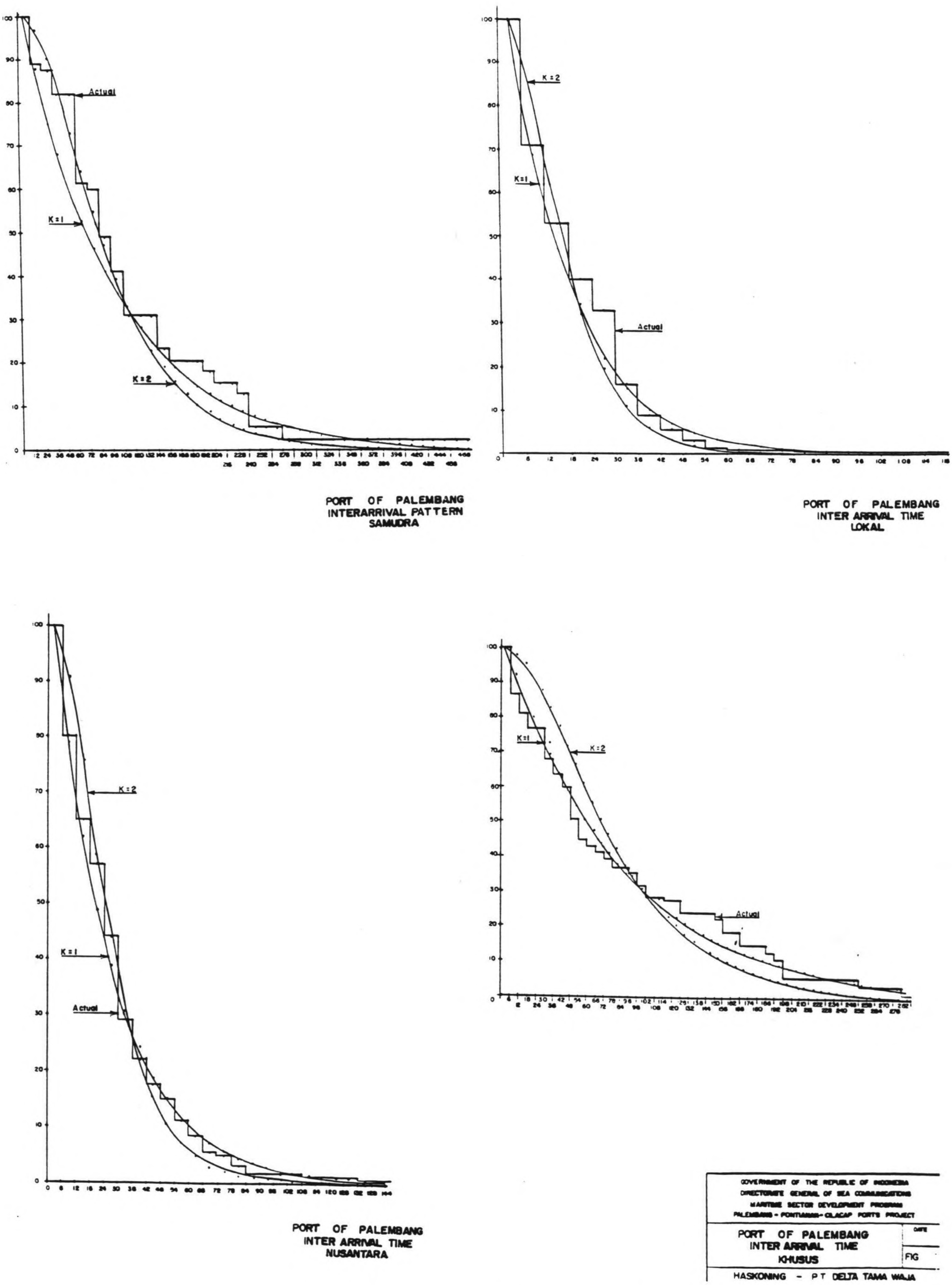


figure B.2.1 The inter arrival distribution of Samudra, Nusantara, Lokal and Khusus vessels.

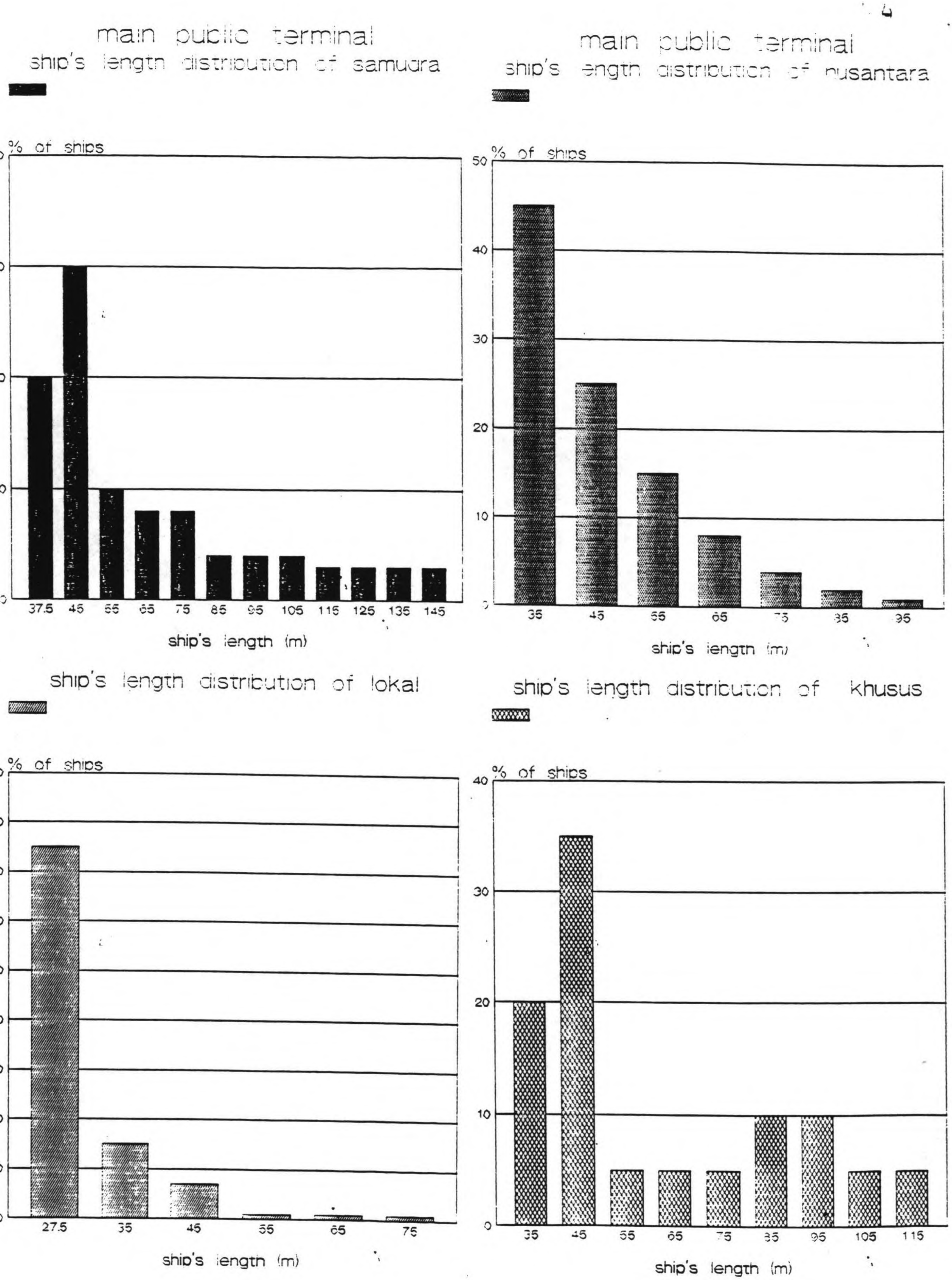
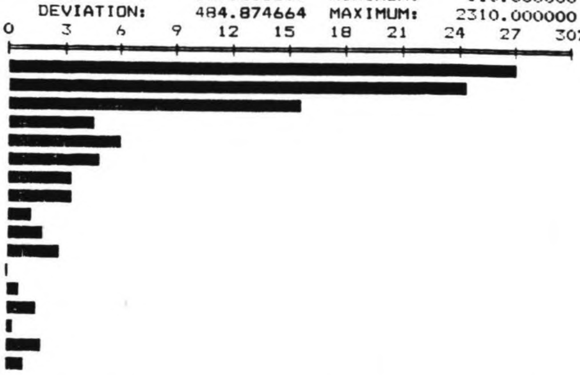


figure B.2.2 The Ship's length distribution of Samudra, Nusantara, Lokal and Khusus vessels.

=== PERSONAL PROSIM HISTOGRAM FACILITY === MODEL IS MPTSIMMO SELECTION IS P

MEAN : 539.801697 MINIMUM: 110.000000
DEVIATION: 484.874664 MAXIMUM: 2310.000000

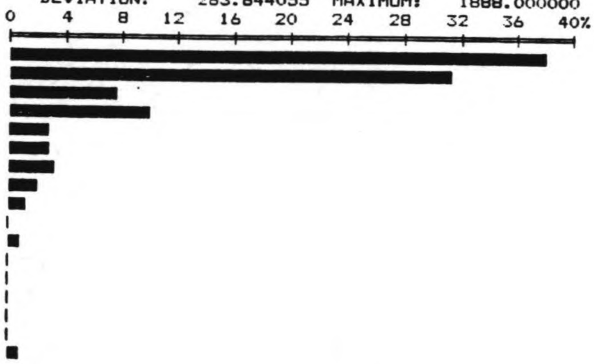
UPPER BOUND	CUM PERC	411 ENTRIES
240.000000	27.0	111
370.000000	51.3	100
500.000000	66.9	64
630.000000	71.3	18
760.000000	77.4	25
890.000000	82.2	20
1020.000000	85.6	14
1150.000000	89.1	14
1280.000000	90.3	5
1410.000000	92.2	8
1540.000000	94.9	11
1670.000000	94.9	0
1800.000000	95.4	2
1930.000000	96.8	6
2060.000000	97.1	1
2190.000000	99.0	8
2320.000000	100.0	4



=== PERSONAL PROSIM HISTOGRAM FACILITY === MODEL IS MPTSIMMO SELECTION IS Q

MEAN : 318.636017 MINIMUM: 96.000000
DEVIATION: 263.844055 MAXIMUM: 1888.000000

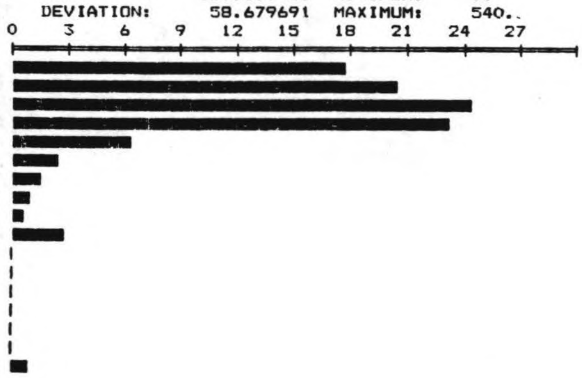
UPPER BOUND	CUM PERC	1719 ENTRIES
202.000000	38.2	656
308.000000	69.2	533
414.000000	76.9	133
520.000000	86.7	169
626.000000	89.5	48
732.000000	92.2	46
838.000000	95.5	57
944.000000	97.0	26
1050.000000	98.1	18
1156.000000	98.1	0
1262.000000	99.1	17
1368.000000	99.1	0
1474.000000	99.1	0
1580.000000	99.1	0
1686.000000	99.1	0
1792.000000	99.1	0
1898.000000	100.0	16



=== PERSONAL PROSIM HISTOGRAM FACILITY === MODEL IS MPTSIMMO SELECTIOr

MEAN : 180.339981 MINIMUM: 10'
DEVIATION: 58.679691 MAXIMUM: 540..

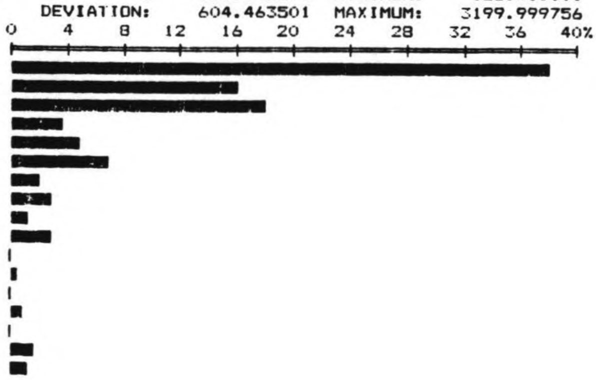
UPPER BOUND	CUM PERC	2575 ENTRIES
134.000000	17.8	459
160.000000	38.3	528
186.000000	62.2	615
212.000000	85.2	593
238.000000	91.6	163
264.000000	94.1	64
290.000000	95.2	29
316.000000	96.2	25
342.000000	96.9	19
368.000000	99.1	58
394.000000	99.1	0
420.000000	99.1	0
446.000000	99.1	0
472.000000	99.1	0
498.000000	99.1	0
524.000000	99.1	0
550.000000	100.0	22



=== PERSONAL PROSIM HISTOGRAM FACILITY === MODEL IS MPTSIMMO SELECTION IS S

MEAN : 633.642273 MINIMUM: 128.000000
DEVIATION: 604.463501 MAXIMUM: 3199.999756

UPPER BOUND	CUM PERC	535 ENTRIES
309.000000	38.1	204
490.000000	54.2	86
671.000000	72.1	96
852.000000	75.9	20
1033.000000	80.7	26
1214.000000	87.5	36
1395.000000	89.3	10
1576.000000	92.1	15
1757.000000	93.3	6
1938.000000	96.3	16
2119.000000	96.3	0
2300.000000	96.6	2
2481.000000	96.6	0
2662.000000	97.6	5
2843.000000	97.6	0
3024.000000	99.3	9
3205.000000	100.0	4



B3. CARGO HANDLING OPERATION

1. Non-container General Cargo Handling [7]

(1) Handling between ship and apron

- Generally ship's gear were employed. The mobile quay crane were mainly needed for assisting ship in case of ship's gear breakdown, and for handling an occasional heavy unit.
- An average of one gang is needed per shiphook (ship's gear).
- The number of gangs (ship's gear), cargo handling rate, and effective working hour, will be given later.

(2) Direct Delivery to Truck (and Barge)

- Normally no equipment (such as forklift truck) is needed.
- For every shiphook, one gang is employed for truck/barge (un)loading.

(3) Handling between apron and transit storage

- Generally, 3 forklift truck were needed for 2 working shiphook. So, the average is 1,5 forklift truck/shiphook.
  Only an estimated 50% of cargo to be (un)stored, has required forklift truck assistance.
  With a view to the time needed for proper maintainance, a forklift should not operate more than 2400 hours per year.
  So, the practical handling capacity of forkliftruck could be set at

  $$\frac{\text{15 ton per hookhour * 2400 hrs}}{\text{1.5 forklift/hook}} = \text{24.000 tons}$$

  per year per FLT.
  The practical lifting capacity of this equipment should be from 2.5 to 3 tons. Probably about 20% of the required number should be of a heavier type, 5 to 7 tons for general cargo (container excluded).

  The ship agents use their own FLT to suplement the port equipment. The contribution of PA's FLT in 1982 is about 40% of use.

- One gang of labour was needed for stacking cargo on pallets on the quay. These pallets were mored by forklift trucks to storage. One gang of labour was needed also, in case without FLT assistance, where horizontal transport take place with handtrucks.

(4) Stacking Cargo in Storage

The cargo is generally not stacked on pallets in storage because delivery to consignee's truck is non palletized and returning empty pallets from the private godown to the port would imply additional costs. Therefore the cargo was taken from pallet and stacked manually. No FLT was needed in this operation.

(5) (Un)loading from/to Truck

- The (un)loading cargo from/to truck, at the rear of the shed or inside the open storage are, were reportedly always done by a manual operation. This operation took place in 15 to 3.5 tons of cargo. Or it is equal 12 tons per truck hour.
- For heavy cargo such as drum, FLT were needed.

From the cost point of view, the ship agent prefered:
- the direct delivery to truck operation.
- the manual operation of handling between apron and transit storage.

2. Container Handling [7]

(1) Handling between ship and apron was used ship's gear (derricks) of sufficient lifting capacity to lift full container.

(2) The port own: 1 unit of heavy forklift truck (top loader of 35 tons capacity, 2 unit of head truck and 6 unit of trailer of 45 tons capacity. These equipment perform horizontal transport from ship-side to storage yard. Even the heavy FLT can do stacking the container. In case of heavy FLT breakdowns, or in peak situation, one mobile crane of 35 tons capacity is required for taking the container off trailer and stacking (the port own 1 unit of this crane).

(3) Because of no container freight station (CFS), the stuffing and stripping of container were carried out n the port's open storage yard of 10.000 m2. This operation can take place either by hand or FLT, and the cargo is loaded directly into consignee's truck, which for that purpose, are parked close-by in the storage area. Thereafter the empty container stacked mostly two, sometimes three high. The tranent time (dwelltime) of 10 days per TEU in the port has been adopted.

(4) Taking into account that each container must be accessible for stuffing and stripping with the consignee's truck standing near-by, the stacking height of FCL's and LCL's is one high and the area needed per TEU is 80 m2.

3. (Un)Loading Operation

The information of (un)loading operation was derived from STR-3 sheet data (year 1986), and Haskoning's findings in 1982.

(1) Ship's gear (working ship's crane)
The number of ship's gear is related to the ship type and ship-size. However, for simplicity, it is assumed that the average of ship's gear per ship will be distinguished according to the ship-type. The result of analysis is:

Ship-type:	Haskoning finding (1982)	Based on 1986 STP-3 sheets
Samudra	2.41	1.74 rounded to 2
Nusantara	1.65	2.16 rounded to 2
Lokal	0.57	1.16 rounded to 1
Khusus	3.43	3.25 rounded to 3

(2) Cargo Handling Rate
Cargo handling rates are expressed in tons per gang-hour. Because of no change on the cargo handling operation, the Haskoning's finding has been adopted:

	Container	Breakbulk	Bags/ pallet	Drums	Other
Samudra	31	19.5	26	-	-
Nusantara	-	13	17.3	-	8.7
Lokal	-	12.2	16.3	-	82
Khusus	-	-	24.5	12.3	-
Shuttle	90	16.2	31.0	-	-
Rbarge	-	-	-	-	20.0

(3) Working Hour
A normal working day is considered from 09.00 hr in the moring to 18.00 hr in the evening with one hour lunch-break. However, the analysis based on the STP-3 sheet data show that the effective working hour are much lower for all ship-type, that is:

(3) Working Hour
A normal working day is considered from 09.00 hr in the moring to 18.00 hr in the evening with one hour lunch-break. However, the analysis based on the STP-3 sheet data show that the effective working hour are much lower for all ship-type, that is:

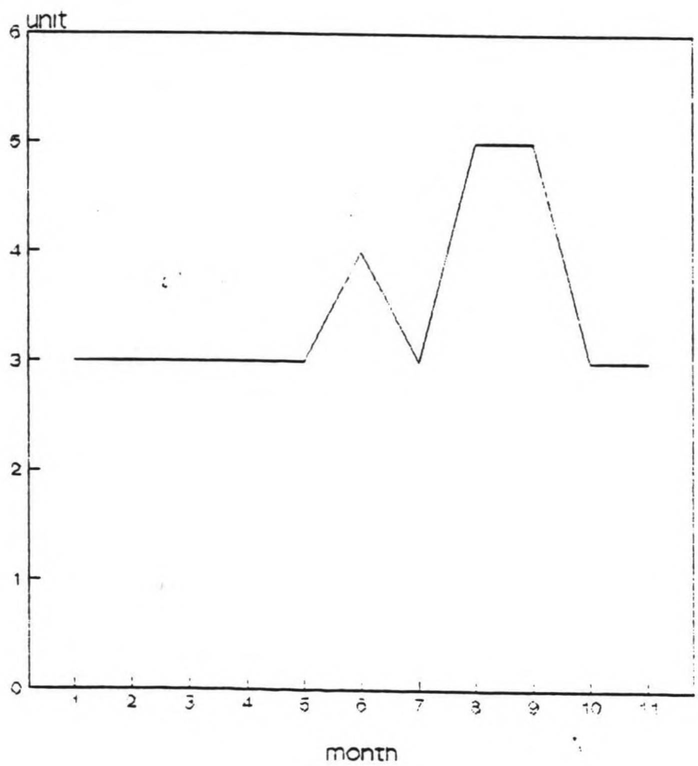
	Available working hour per day (hrs)	Effective working hour per day (hrs)	Effective factor (%)
Samudra	9	5.7	63
Nusantara	9	5.8	64
Lokal	9	4.5	50
Khusus	9	3.1	34

4. Mobile Quay-Crane for Performance.

The following findings were formulated based upon STP-4 statement of Usage of Port Equipment, year 1986.

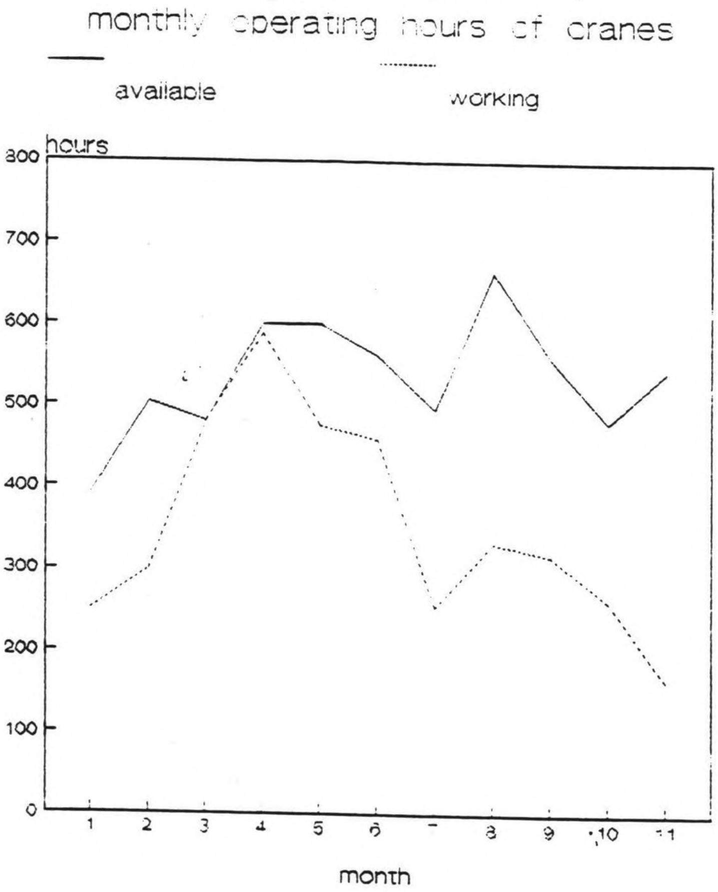
(1) Number of Crane: Available, Operation.
There are 6 cranes, with capacity range from 15 tons to 35 tons, which available and operated during 1986.

figure B3.1
number of operating cranes (out of 6)



(2) The Available Hours and Working Hours of Cranes (monthly).

figure B3.2



Note:

(1) The available hours (max.) of one crane per month is about 200 hours.

(2) The available cranes are too heavy for loading and unloading barge, and assisting a ship in case of ship-gear breakdown.

(3) The mobile quay crane are used not only for (un)loading operation, but also for yard operation. Thus, the above performance record does not show a separate record for mere (un)loading operation.

Boom Baru Quay -

Cource: SPT - 3 sheets

1986	effect. hours worked	no gangs worked	loaded and disch.	quay capac. p.month	total length of ships at quay	no. of ships at quay	average ship length	quay utili-zation	berth occup.	average req.berth length	average berthing time	average ship load
	hours	gang	ton	m' x hr	m'	ships	m'	m' x hr	%	m	hrs	ton
(1)	(2)	(3)	(4)	(6)	(7)	(8)	(9) = (7) : (8)	(10)	(11) = (10) = (6) x 100%	(12) = 9+5m	(13) = 10:12	(14) 4 ÷ 8
Samudra	2138	208	105.132	735 *	122.32	190	64.4	629.534	9.78	69.4	47.74	553.3
Nusantara	1672	256	82.790	24	11.469	259	44.3	617.152	9.58	49.3	48.33	319.7
Lokal	3963	331	59.742	6.438.600	10.099	334	30.2	915.801	14.22	35.2	77.90	178.9
Khusus	748	62	59.097		5.598	92	60.85	548.567	8.52	65.85	90.55	642.4
Total			306.761						42.10			

Productivity = 306.761 ÷ = 417.4 = 420 ton p. meter p. year.

Boom Baru Quay - Samudra

Source: SPT - 3 sheets

1986	effect. hours worked	no gangs worked	loaded and disch.	total length of ships at quay	no. of ships at quay	average ship length	quay utili-zation	average req.berth length	average ship load
	hours	gang	ton	m'	ships	m'	m' x hr	m	ton
(1)	(2)	(3)	(4)	(7)	(8)	(9) = (7):(8)	(10)	(12) = 9+5m	(14)
January	111	16	3001	988	16	61.8	39900	66.8	187.6
February	40	6	427	491	7	70.1	20127	75.1	61
March	223	24	5812	1271	20	63.6	53359	68.6	290.6
April	202	16	10297	523	10	52.3	24526	57.3	1029.7
May	255	23	13063	1144	18	63.6	52022	68.6	725.7
June	121	13	4529	997	15	66.5	39915	71.5	301.9
July	137	11	2519	1131	23	50.2	65403	54.2	109.5
August	165	13	6328	650	11	59.1	24448	64.1	575.3
September	370	15	18439	1491	18	82.8	76086	87.8	1024.4
October	124	12	7270	813	12	67.8	54097	72.8	605.8
November	167	25	16039	1179	19	62.2	72059	67.2	844.2
December	223	34	17404	1554	21	74.0	74323	79.0	828.8

Boom Baru Quay - Lokal

Source: SPT - 3 sheets

1986	effect. hours worked	no gangs worked	loaded and disch.	total length of ships at quay	no. of ships at quay	average ship length	quay utili-zation	average req. berth length	average ship load
	hours	gang	ton	m'	ships	m'	m' x hr	m	ton
(1)	(2)	(3)	(4)	(7)	(8)	(9) = (7):(8)	(10)	(12) = 9+5m	(14) = 4 ÷ 8
January	421	19	5152	780	27	28.9	64976	33.9	190.8
February	336	24	5414	680	22	30.9	57962	35.9	246.1
March	353	17	4469	736	23	32.0	55086	37.0	194.3
April	637	37	5829	967	32	30.2	86373	35.2	182.2
May	578	58	7658	1120	35	32.0	115487	37.0	218.8
June	297	32	3801	663	22	30.1	88360	35.1	172.8
July	485	49	6711	1106	36	30.7	97945	35.7	186.4
August	284	17	4098	656	21	31.2	53270	36.2	195.1
September	300	17	4041	893	31	28.8	86889	33.8	167.4
October	276	31	5860	1055	35	30.1	88396	35.1	167.4
November	142	16	3440	716	25	28.6	67485	33.6	137.6
December	177	14	3269	727	25	29.1	53572	34.1	130.8

Boom Baru Quay - Khusus

Source: SPT - 3 sheets

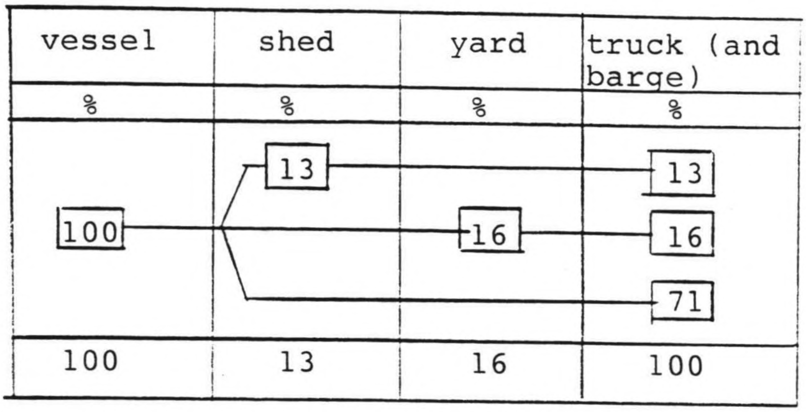
1986	effect. hours worked	no gangs worked	loaded and disch.	total length of ships at quay	no. of ships at quay	average ship length	quay utili-zation	average req.berth length	average ship load
	hours	gang	ton	m'	ships	m'	m' x hr	m	ton
(1)	(2)	(3)	(4)	(7)	(8)	(9) = (7):(8)	(10)	(12) = 9+5m	(14) = 4 ÷ 8
January	62	2	3100	596	10	59.6	50724	64.6	310
February	27	4	2500	386	8	48.2	13489	53.2	312.5
March	18	3	1110	630	13	48.5	35765	53.5	85.4
April	55	7	3410	944	17	55.5	164249	60.5	200.6
May	48	4	5000	599	8	74.9	56885	79.9	625
June	83	7	4500	337	4	84.2	27420	89.2	1125
July	96	8	6873	392	5	78.4	52926	83.4	1374.6
August	177	8	11350	500	8	62.5	52092	67.5	1418.8
September	42	4	5000	471	7	67.3	32105	72.3	714.3
October	39	4	4850	265	4	66.2	22199	71.2	1212.5
November	101	11	11404	478	8	59.8	58713	64.8	1425.5
December	-	-	-	-	-	-	-	-	-

5. Cargo Movement through Terminal

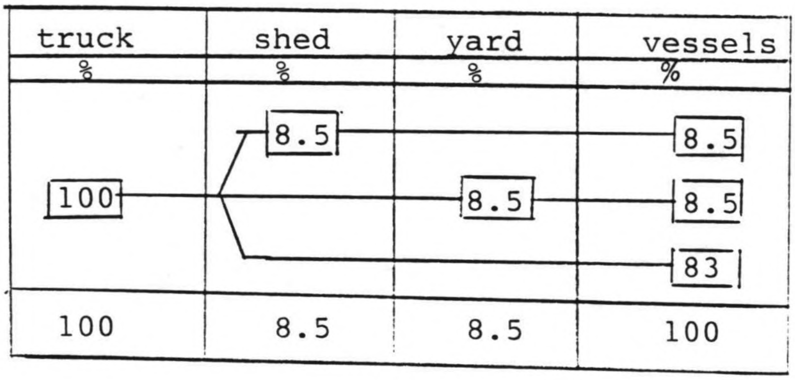
The STP-7b sheet (year 1986), statement of cargo flow from and to ship, show the following findings:

(1) Inbound and Outbound Movement - 1986:

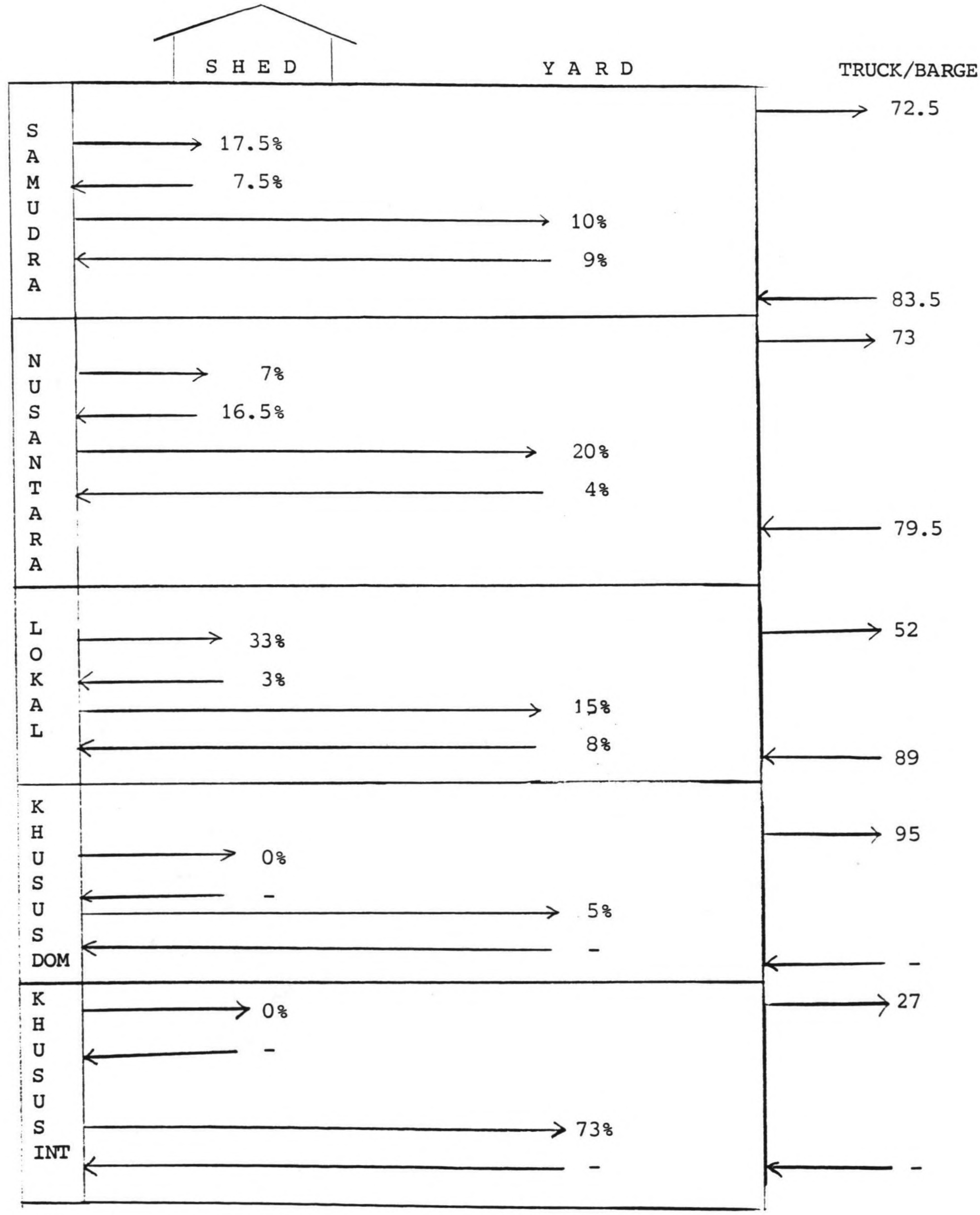
Inbound:



Outbound:



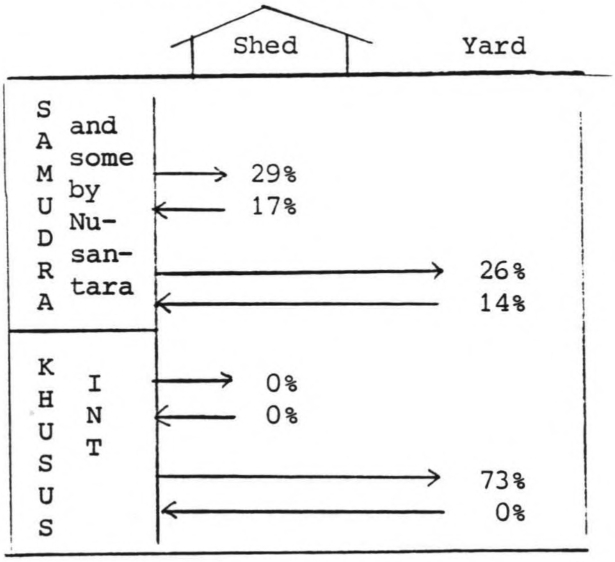
(2) Cargo Flow from and to Ship



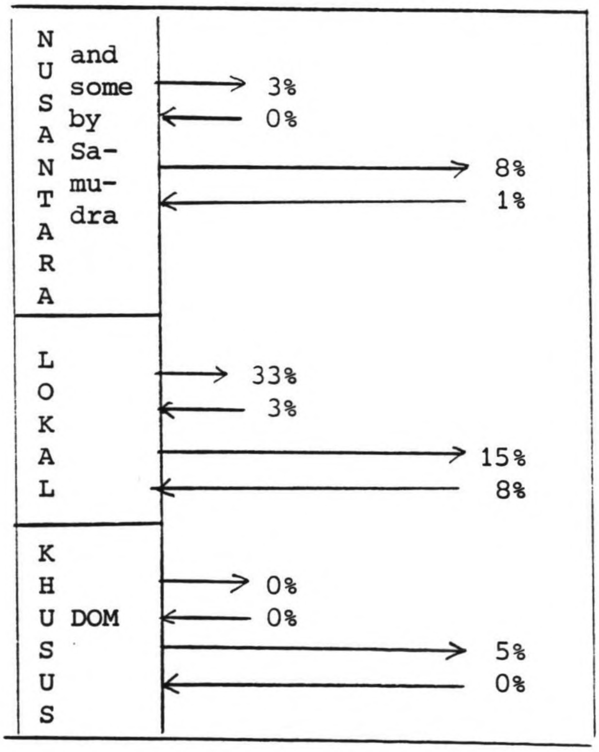
Inbound and Outbound Cargo Movement
through Terminal - 1986.

(3) International and Domestic Cargo through Shed/Yard

INTERNATIONAL CARGO:



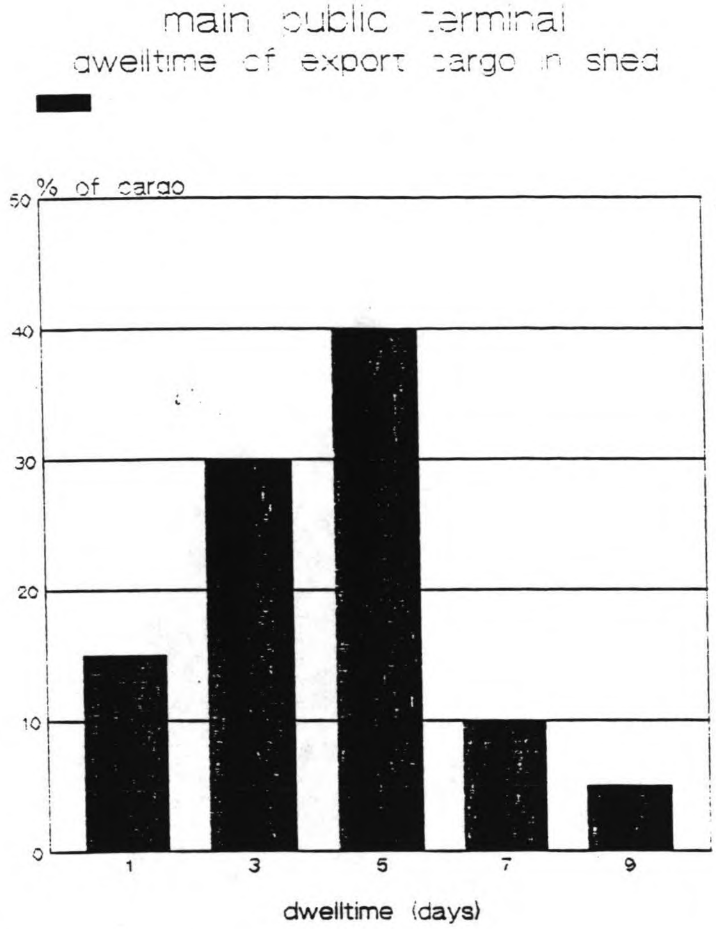
DOMESTIC CARGO:

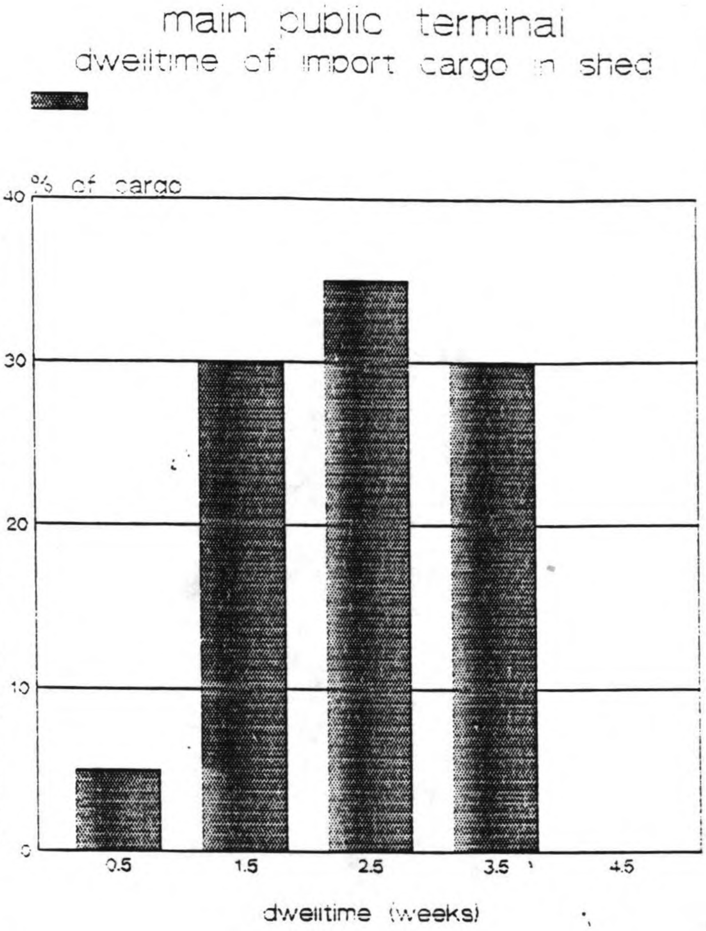


International and Domestic Cargo Movement through Terminal - 1986

6. Dwelltime of Cargo in Shed/Yard.

The most relevant data concerning the dwelltime of cargo stored in shed and yard, was found in the STP-6a - statement of Usage of Storage facilities. The following findings were based upon STP-6a year 1986.





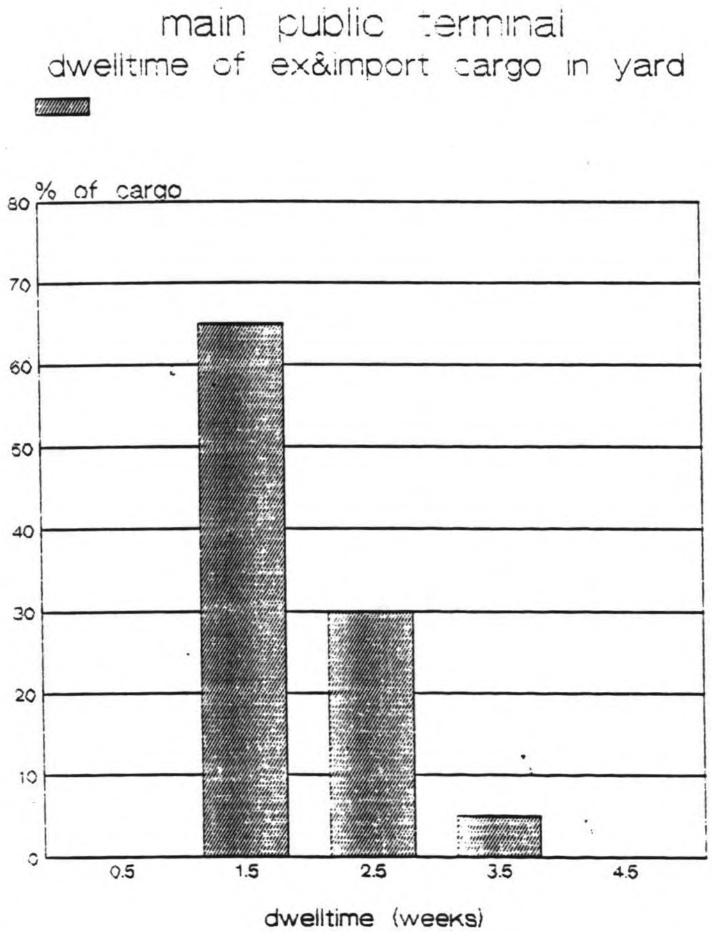
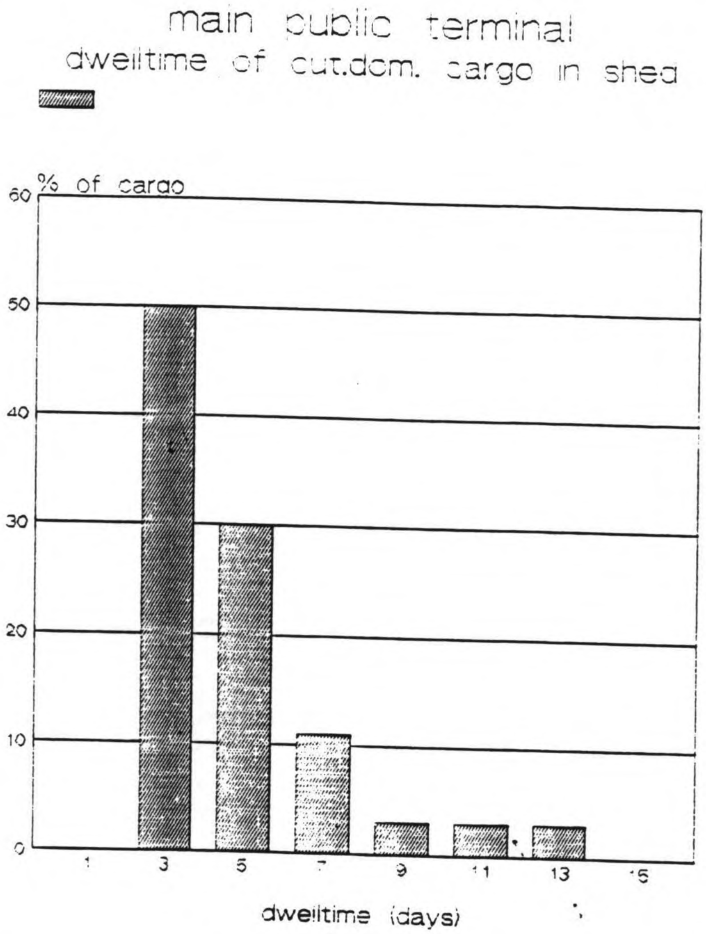
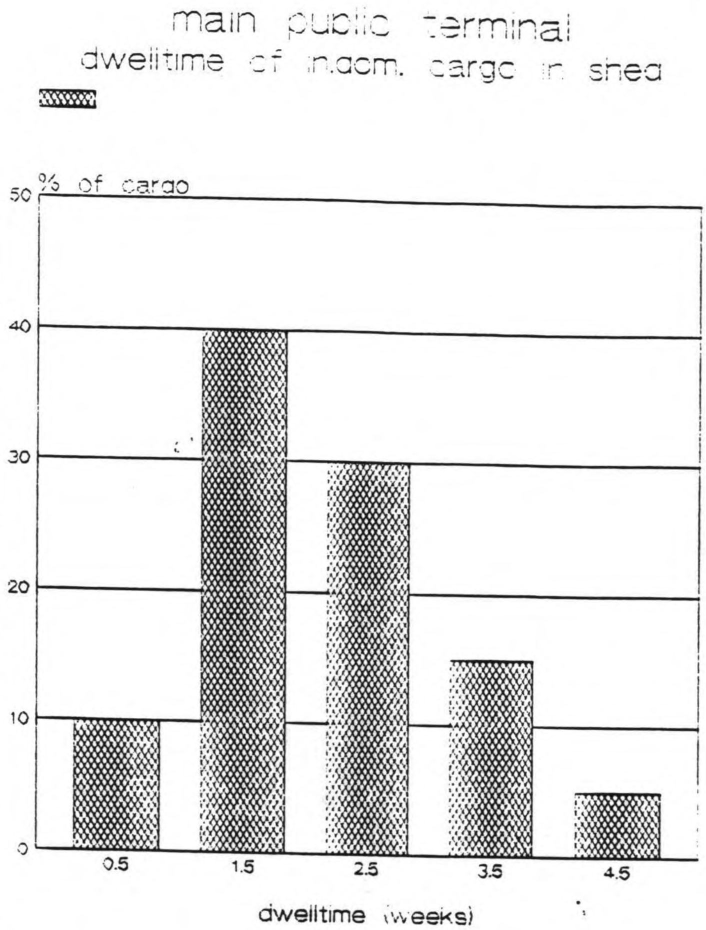


figure B3.3 Dwelltime of international cargo in storage facilities.





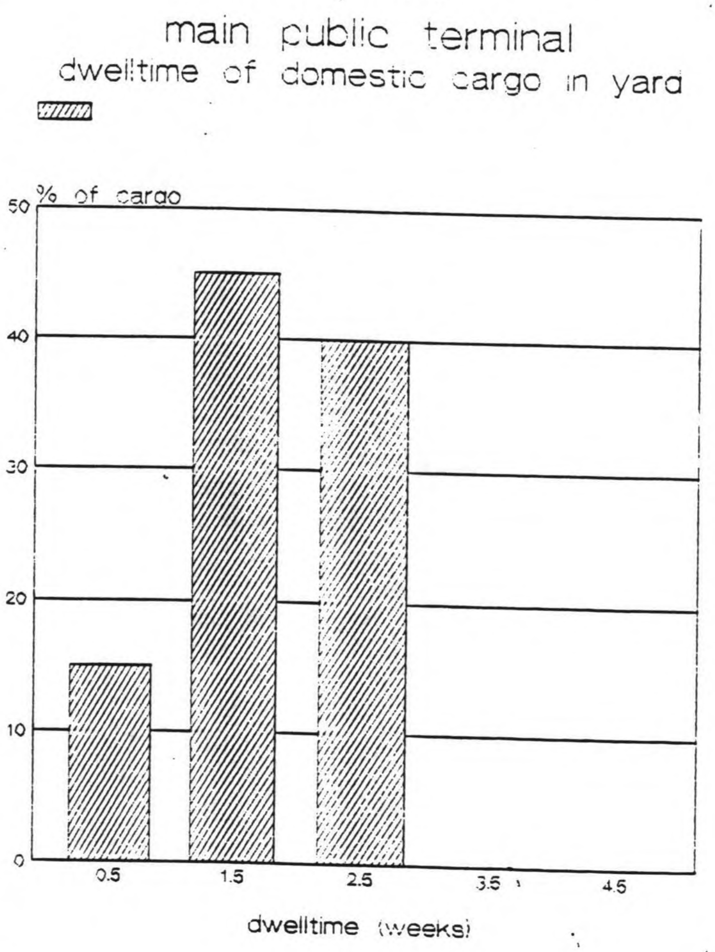


figure B3.4 Dwelltime of domestic cargo in storage facilities.

Annex C. Future Ship and Cargo Handling Analysis

C.1 Size of Shuttle Vessel

From the technical requirement: limited depth of existing international terminal quay and navigational channel along Musi river, the appropiate max laden draft of shuttle should not be more than 7 m. But the right size of that vessel can be estimated roughly from an economic point of view. Within this study the overimplified cost model has been used in the calculation. The assumption are as follows [7]:

- the ship will only make trips between the gateway port of Tanjungpriok and Palembang, and will not be used for other ports.
- the sailing distance Tanjungpriok Palembang is 345 miles, but along Musi river, for 90 miles, the ship is estimated about at half speed. Therefore the "time oriented" distance will be 435 miles. The average speed is 12.5 knots.
- the average load factor is 0.50.
- the cargo handling speed for the average mix of cargo, is estimated in case of night work: 2 gangs (crane) * 20 hrs/day * 50 ton/ghr = 2000 ton/day.
- No waiting time for berth.

The cost per ton of cargo carried can be calculated from:

$$C/ton = \frac{Cp \cdot Tp + Cs \cdot Ts}{L}$$

in which:
Cp = cost per day in port
Tp = time (in day) spent in port
Cs = cost per day at sea
Ts = time (in day) spent at sea
L = cargo carried

where:

$$Cp = 73.61\ DWT\ 0.54 + 0.07\ DWT \text{ (in US \$)}$$

$$Cs = 115.78\ DWT\ 0.53 + 0.07\ DWT$$

$$Tp = \frac{2 * 0.5 * DWT}{2000} = 0.0005\ DWT$$

$$Ts = \frac{M}{263 + 0.0048\ DWT} = \frac{435}{263 + 0.0048\ DWT}$$

$$L = 0.050 * DWT$$

Based on those assuption and formula, the calculation of C/ton as follows:

DWT	Cp (US $)	Tp (day)	Cs (US $)	Ts (day)	L (ton)	C/tor (US $/ton)
1000	3138.5	0.5	4574.4	1.62	500	17.96
2000	4601.6	1.0	6644.0	1.60	1000	15.23
3000	5763.7	1.5	8273.2	1.57	1500	14.42
4000	6767.1	2.0	9671.3	1.54	2000	14.21 *)
5000	7667.8	2.5	10920.3	1.52	2500	14.31
6000	8494.9	3.0	12062.7	1.49	3000	14.49

From the table above, the economical shipsize is therefore 4000 DWT, which has the following physical properties:

- average length = 100 m
- loden draft = 6.5 m

C2. Future Container Handling Operation

Port operation system can be described as an administration of port facilities (space and equipment) and organisation of labour; in order to fulfill the function of port as a transfer terminal and an interim storage in total chain of transport, where goods (and sometimes, passenger) being tranfered from sea to land and vise versa; by performing the interrelated management and control of loading/discharging, routing/moving, storing/warehousing, receiving/delivery of cargo.

These activities become complicated, especially in the general cargo port/terminal, due to the so wide variety of packaging form of general cargo, such as unitized cargo (container, pallet), and breakbulk cargo (cases, carton, loose drum and heavy lift).

Furthermore, there is always an inherent feature of cargo handling operation, that is an unforeseen, unpredictable charges and development in cargo handling methodology and shipping technology. Therefore, in order to cope with this problem, the one important philosophy in the port operation design is the flexibility.

In the MPT terminal, there are two major cargo flow, namely: container via international subterminal, and non-container cargo (NCC) via either international or domestic terminal.

The anticipated future cargo handling operation are:

(I) the present domestic NCC cargo handling is expected to continue in the future.

(II) the horizontal transport of international NCC to shed will fully be assisted by forklift, and to yard will be carried by tractor-trailer combination.

(III)the container handling will be investigated further.

From the qualitative comparison shown in the table c.2.1 (aspect 1 to 9 are adopted from the consultant analysus [7]), the Heavy forklift system is the most favourable based on the consideration that this system is superior in almost comparated aspects. The important aspect is that it is probably the most economical due to the existing system is the Heavy forklift system.

The figure c.2.1 and c.2.2 explain the container flow in the MPT terminal [7]. However it is useful to incorporate the following information with regard to the Heavy Forklift and trailer operation:

- For tranfer of container between ship and apron, the ship's gear/cranes are employed. They are assisted by one mobile quay crane.
- Horizontal transport of container between quay and container (storage) yard and between CFS and CY is carried

out by a tractor trailer combinations.

- Heavy Forklifts carry out the stacking of container in CY.
- Stuffing and striping of container (which remains on the trailer) can be performed in the yard or one side of the CFS shed.
- Vertical movement of cargo for loading/unloading of the trailer (truck) is carried out by forklift trucks.

With regard to the time needed, the following figure are given based on the consultant report [7]:

1. 1 cycle: stack to trailer by FLT = 2.5 minutes.
2. 1 cycle: stack - tranfer point by FLT = 3.0 minutes.
3. 1 cycle: stack - quay - stack of tractor + trailer in combination with FLT = 6.0 minutes.

Recapitulation of cycle times:

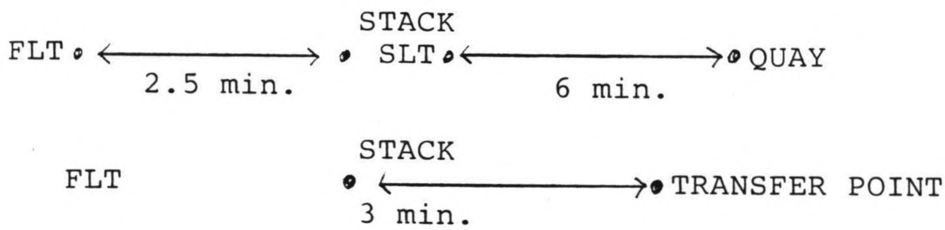


Table C 2.1. Qualitative system comparison

No.	Requirements	Chasis	Heavy forklift	Straddle carrier	Side loader	Railmounted transtainer	Rubber tired transtainer	Remarks
1	Reliability	+	+	0/+	0	+	+	
2	Controlability	+	0	0	0	+	+	
3	Flexibility	++	++	++	++	--	--	
4	Space utilization	--	- *) ++**)	0	-	++	+	*) Row-stacking **) Block-stacking
5	Implementation in phases	++	++	++	++	-	0	
6	Safety	+	-	--	-	+	0	
7	Educational & Experience leven personnel	-	0	--	-	0	0	
8	Operational costs	0	0	-/--	-	+	0	Incl. maintenance
9	Investments	-	0	0	0	--	-	
10	Compatibility with existing	-	++	-	-	-	-	Existing equipment is Heavy Forklift

Legend: 1 - 6 : ++ = very good; + = good; 0 = moderate; - = bad; -- = very bad

7 - 9 : ++ = very low; + = low; 0 = moderate; - = high; -- = very high

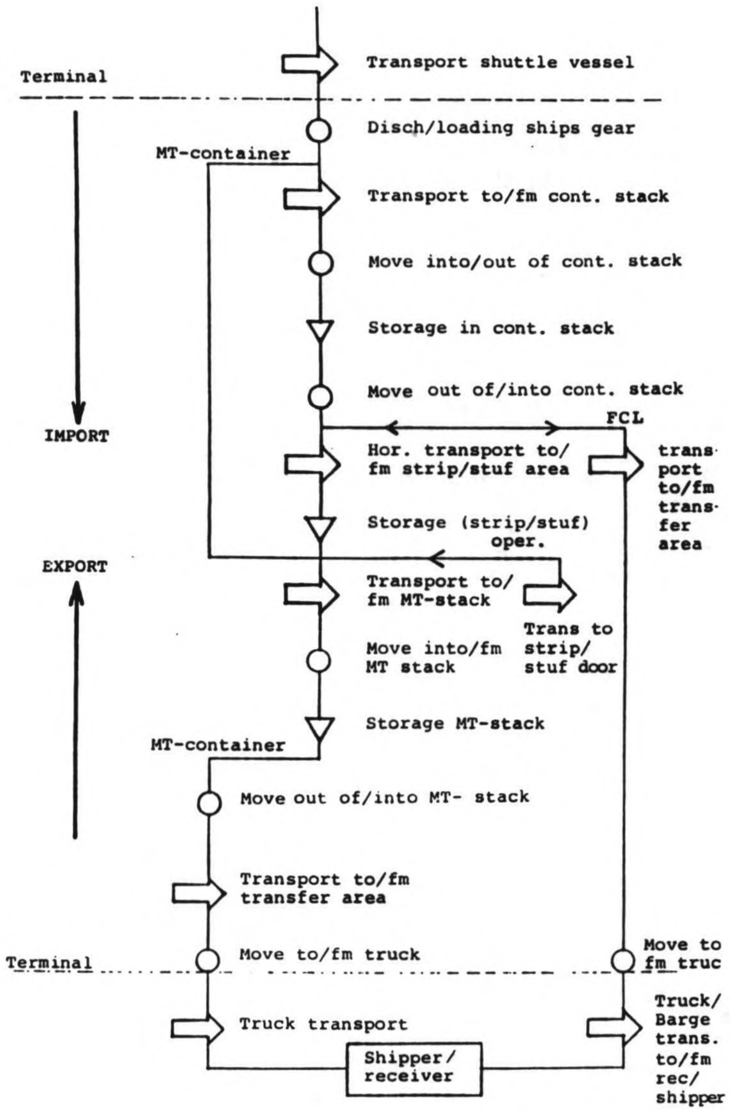


figure C2.1 Basic flow of LCL/ FCL/MT. containers.

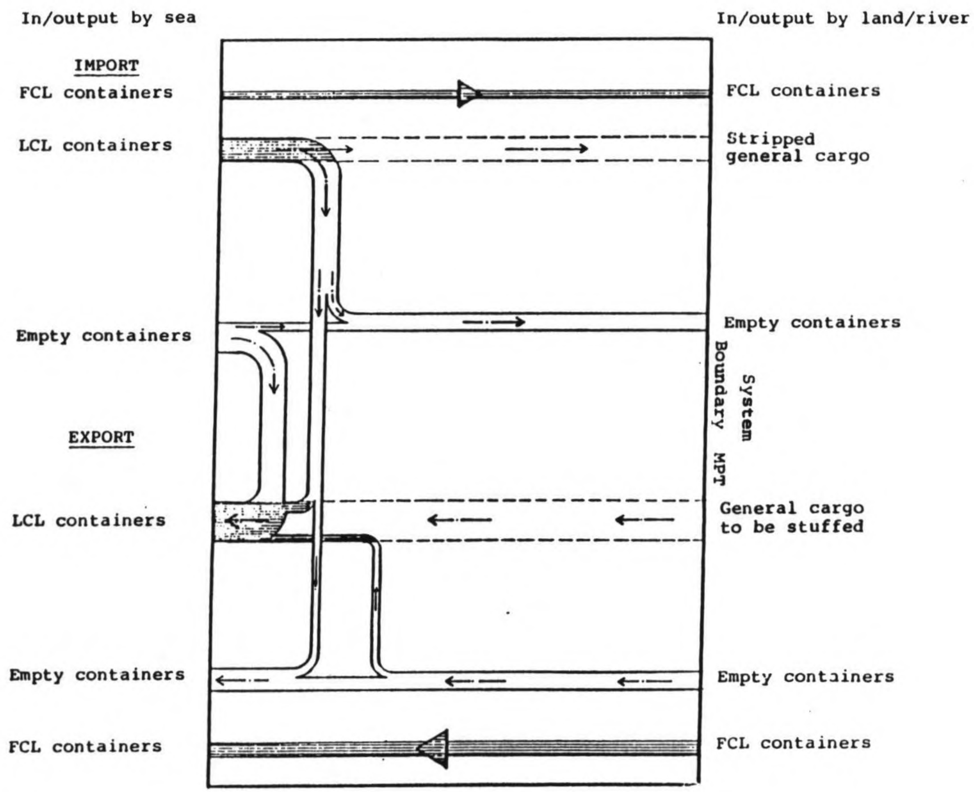


figure C2.2 Qualitative container flow

C3. Hourly Ship's Cost in Port

The graphs which showed relationship between daily ship's cost in port and its corresponding size (DWT) have been set up by Haskoning [7]. Based on these graph, the equation of hourly ship's cost in port as a function of its corresponding size (length) has been developed, using the following assuptions:

- Samudra, Nusantara, Lokal and Khusus follow the graph of general cargo ship, whereas the shuttle ship follows the graph of container ship. The cost of rubber barge was based on the rental price of an equivalent size of barge in South Sumatra.
- the cost of approximately 25% higher than the 1983 Haskoning's assesment has been taken.

The equations were:

1. Shuttle ship: $Y = 6.25 * x - 345$

2. Non Shuttle ship:

$X < 60$	$Y = 3.10 * X - 74$
$60 < X < 100$	$Y = 2.20 * X - 20$
$X > 100$	$Y = 6.70 * X - 470$

3. Rubber barge $Y = 5.00$

   Where: Y = hourly ship's cost in port (US $)
   X = ship's length (m)

Annex D:

MPTSIM Program

Input

Output

```
A DEFINITION SECTION

COMPONENT      : PORTADM SURVEYOR
CLASS          : GENERATOR SHIP(300) CARGO(1000)
QUEUE          : PREARRIVAL WAITINGROW QUAY[2]
INPUTSTREAM    : DATAPORT
OUTPUTSTREAM   : RESULT
RANDOMSTREAM   : INTARR[7] SLENGTH[2] SCARGO[2] UNIF[22]
TIMEUNIT       : HOUR

ATTRIBUTES OF MAIN :
 REAL     : INTQUAYLENGTH DOMQUAYLENGTH FREEQUAY[2]
 REAL     : CARGOINSHED[3] CARGOINYARD[3]
 REAL     : VIASHED[2,3] VIAYARD[2,3]
 REAL     : RUNTIME SUBRUNTIME RUNINTIME
 REAL     : NO[6,20] SL[6,20] SC[6,20] BT[6,20] BO[6,20]
 REAL     : TNO[6] TSL[6] TSC[6] TBT[6] TBOR[6] TOTBOR[20] AVTBOR
 REAL     : TWT[6] TMU[6] TUT[6] TLT[6] TIT[6] TPT[6] TCO[6]
 INTEGER  : NORUN YEARRUN TOTGEN TOTSHIPTYPE NSS[6,2] NSD[7]
 INTEGER  : SR G H I J K  L M N O P  QUAYCRANE FREEQUAYCRANE
 REFERENCE TO GENERATOR : GEN[7]
 REFERENCE TO SET : SHUTTLESET NONSHUTTLESET CRANESHIPSET MAYSTOPSHIPSET
ATTRIBUTES OF GENERATOR :
 REAL     : ARR1 ARR2 SL1 SL2  SC1 SC2 MEANCARGO
 REAL     : GENINTARR GENLENGTH GENCARGO GENINBOUND GENINCONTAINER
 REAL     : GENCONT GENPALL GENBULK GENBAGS GENOTHER GENOUTCONTAINER
 REAL     : GENCONTRATE GENPALLRATE GENBULKRATE GENBAGSRATE GENOTHERATE
 REAL     : GNCCINSHED GNCCINYARD GNCOUTSHED GNCOUTYARD
 REAL     : GCONINSHED GCONINYARD GCOOUTSHED GCOOUTYARD
 REAL     : GENMOOR GENUNMOOR GENWORKHOUR GENEFFWORK
 INTEGER  : NOGEN GENNO GENPRIOR GENTRADE GENRANDOM
 CHARACTER(9): GENTYPE
ATTRIBUTES OF SHIP :
 REAL     : SHIPLENGTH REQUAYLENGTH SHIPCOST SHIPCARGO FQL1
 REAL     : SHIPINBOUNDCARGO SHIPOUTBOUNDCARGO INBOUNDCARGO OUTBOUNDCARGO
 REAL     : NCCINSHED NCCINYARD NCOUTSHED NCOUTYARD INCONTAINER
 REAL     : CONINSHED CONINYARD COOUTSHED COOUTYARD OUTCONTAINER
 REAL     : HANDLINGRATE WORKINGHOUR EFFWORKING NORMBERTHINGTIME
 REAL     : UNLOADINGPERHOUR LOADINGPERHOUR DATE TIME
 REAL     : ARRIVALATPORT STARTWAITING[3] ENDWAITING[3] WAITINGTIME
 REAL     : MOORINGTIME UNMOORINGTIME LOADINGTIME UNLOADINGTIME IDLETIME
 INTEGER  : SN SHIPTRADE SHIPPRIORITY SUBTERMINAL
 INTEGER  : SHIPCRANE REQUAYCRANE  ADQUAYCRANE
 CHARACTER(9) : SHIPTYPE
 CHARACTER(4) : CARGOHANDLING
 MACRO        : CARGOIN CARGOUT CRANEPLANNER
ATTRIBUTES OF CARGO :
 REAL         : AMOUNT DWELLTIME STARTSTORAGE DATES TIMES
 INTEGER      : ROUTE RANDOMDT
ATTRIBUTES OF PORTADM :
 REFERENCE TO SHIP : PASHIP STOPSHIP

A PROCESS OF MAIN

SHUTTLESET ← NEW SET
NONSHUTTLESET ← NEW SET
CRANESHIPSET ← NEW SET
MAYSTOPSHIPSET ← NEW SET

NORUN ← READ FROM DATAPORT
YEARRUN ← READ FROM DATAPORT
RUNTIME ← READ FROM DATAPORT
RUNINTIME ← READ FROM DATAPORT
RUNINTIME ← 30.0 IF NORUN = 1
SR ← READ FROM DATAPORT
SUBRUNTIME ← 365.0 ÷ SR
INTQUAYLENGTH ← READ FROM DATAPORT
DOMQUAYLENGTH ← READ FROM DATAPORT
FREEQUAY[1] ← INTQUAYLENGTH + 10.0
FREEQUAY[2] ← DOMQUAYLENGTH + 10.0
QUAYCRANE ← READ FROM DATAPORT
FREEQUAYCRANE ← QUAYCRANE
FOR H ← 1 TO 22
  RESHAPE UNIF[H] AS SAMPLED FROM DISTRIBUTION UNIFORM WITH PARAMETERS
    LB(0) UB(100)
END
TOTGEN ← READ FROM DATAPORT
TOTSHIPTYPE ← READ FROM DATAPORT
FOR I ← 1 TO TOTGEN
  GEN[I] ← NEW GENERATOR
  THIS GENERATOR ← GEN[I]
  GENTYPE  ← CHREAD FROM DATAPORT
  NOGEN    ← I
  GENNO    ← READ FROM DATAPORT
  GENTRADE ← READ FROM DATAPORT
  GENPRIOR ← READ FROM DATAPORT
  ARR1 ← READ FROM DATAPORT
  ARR2 ← READ FROM DATAPORT
  RESHAPE INTARR[I] AS SAMPLED FROM DISTRIBUTION NORMAL WITH PARAMETERS
    MEAN(ARR1) DEVIATION(ARR2) IF GENTYPE ="SHUTTLE"
  RESHAPE INTARR[I] AS SAMPLED FROM DISTRIBUTION EXPONENTIAL WITH
    PARAMETER MEAN(ARR1) IF GENTYPE ≠"SHUTTLE"
  IF (GENTYPE="SHUTTLE")∨GENTYPE="RBARGE"
    SL1 ← READ FROM DATAPORT
    SL2 ← READ FROM DATAPORT
    RESHAPE SLENGTH[I-5] AS SAMPLED FROM DISTRIBUTION UNIFORM WITH
                                    PARAMETERS LB(SL1) UB(SL2)

    SC1 ← READ FROM DATAPORT
    SC2 ← READ FROM DATAPORT
    RESHAPE SCARGO[I-5] AS SAMPLED FROM DISTRIBUTION UNIFORM WITH
                                    PARAMETERS LB(SC1) UB(SC2)

  END
  IF (GENTYPE≠"SHUTTLE")∧GENTYPE≠"RBARGE"
    MEANCARGO ← READ FROM DATAPORT
  END
  GENINBOUND ← READ FROM DATAPORT
  GENINCONTAINER  ← READ FROM DATAPORT
  GENOUTCONTAINER ← READ FROM DATAPORT
  GENCONT ← READ FROM DATAPORT
  GENPALL ← READ FROM DATAPORT
  GENBULK ← READ FROM DATAPORT
  GENBAGS ← READ FROM DATAPORT
  [illegible]
  GENBULKRATE ← READ FROM DATAPORT
  GENBAGSRATE ← READ FROM DATAPORT
  GENOTHERATE ← READ FROM DATAPORT
  GNCCINSHED ← READ FROM DATAPORT
  GNCCINYARD ← READ FROM DATAPORT
  GNCOUTSHED ← READ FROM DATAPORT
  GNCOUTYARD ← READ FROM DATAPORT
  GCONINSHED ← READ FROM DATAPORT
  GCONINYARD ← READ FROM DATAPORT
  GCOOUTSHED ← READ FROM DATAPORT
  GCOOUTYARD ← READ FROM DATAPORT
  GENMOOR ← READ FROM DATAPORT
  GENUNMOOR ← READ FROM DATAPORT
  GENWORKHOUR ← READ FROM DATAPORT
  GENEFFWORK ← READ FROM DATAPORT
  GEN[I] ← THIS GENERATOR
  ACTIVATE GEN[I] FROM GENSTART IN GENERATORMOD
END
ACTIVATE PORTADM FROM PASTART IN PORTADMMOD
ACTIVATE SURVEYOR FROM SVYSTART IN SURVEYORMOD
HOLD RUNTIME DAYS
WRITE "RESULT OF RUN NO :";NORUN;"YEAR :";YEARRUN TO RESULT WITH IMAGE
      xxxxxxxxxxxxxxxxxφxxxφxxxxxxxxxxφxxxxx
WRITE " " TO RESULT WITH IMAGE x
WRITE "1. BERTH UTILIZATION" TO RESULT WITH IMAGE
      xxxxxxxxxxxxxxxxxxxx
WRITE " " TO RESULT WITH IMAGE x
WRITE "SHIPTYPE  NO  SHIPCALL  SHIPLENGTH  SHIPCARGO BERTHINGTIME  BOR "
   TO RESULT WITH IMAGE
      xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
WRITE "                              (M)        (TON)       (HOURS)   (0/0)"
   TO RESULT WITH IMAGE
      xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
FOR L ← 1 TO TOTSHIPTYPE
 WRITE " " TO RESULT WITH IMAGE x
 WRITE "SAMUDRA" TO RESULT WITH IMAGE xxxxxxx IF L = 1
 WRITE "NUSANTARA" TO RESULT WITH IMAGE xxxxxxxxx IF L = 2
 WRITE "LOKAL" TO RESULT WITH IMAGE xxxxx IF L = 3
 WRITE "KHUSUS" TO RESULT WITH IMAGE xxxxxx IF L = 4
 WRITE "SHUTTLE" TO RESULT WITH IMAGE xxxxxxx IF L = 5
 WRITE "RBARGE" TO RESULT WITH IMAGE xxxxxx IF L = 6
 FOR M ← 1 TO K
   TNO[L] ← TNO[L] + NO[L,M]
   TSL[L] ← TSL[L] + SL[L,M]÷NO[L,M]
   TSC[L] ← TSC[L] + SC[L,M]÷NO[L,M]
   TBT[L] ← TBT[L] + BT[L,M]÷NO[L,M]
   TBOR[L]←TBOR[L] + BO[L,M]×SR×100.0
   TOTBOR[M]←TOTBOR[M] + BO[L,M]×SR×100.0
   WRITE M;NO[L,M]×SR;SL[L,M]÷NO[L,M];SC[L,M]÷NO[L,M];BT[L,M]÷NO[L,M];
         BO[L,M]×SR×100.0 TO RESULT WITH IMAGE
         xxxxxxxxxxxxφxxxxxxφxxxxxxxx.xxφxxxxxxxx.xxφxxxxxxxx.xxφxxxx.xx
 END
 WRITE " " TO RESULT WITH IMAGE x
 WRITE "AVERAGE" TO RESULT WITH IMAGE xxxxxxxxxxxxx
 WRITE TNO[L]×SR÷K;TSL[L]÷K;TSC[L]÷K;TBT[L]÷K;TBOR[L]÷K TO RESULT WITH
   IMAGE xxxxxxxxxxxxxxxxxxxφxxxxxxxx.xxφxxxxxxxx.xxφxxxxxxxx.xxφxxxx.xx
END
WRITE " " TO RESULT WITH IMAGE x
WRITE "SUBRUN     BERTH OCUPANCY RATIO OF MPT (0/0)" TO RESULT WITH IMAGE
      xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
FOR N ← 1 TO K
```

```
[109]    AVTBOR ← AVTBOR + TOTBOR[N]÷K
[110]    WRITE N;TOTBOR[N] TO RESULT WITH IMAGE
             xxxx*xxxxxxxxxxxxxxxxxxxxxxx.xx
[111] END
[112] WRITE " " TO RESULT WITH IMAGE x
[113] WRITE "AVERAGE";AVTBOR TO RESULT WITH IMAGE
             xxxxxxx*xxxxxxxxxxxxxxxxxxx.xx
[114] WRITE " " TO RESULT WITH IMAGE x
[115] WRITE " " TO RESULT WITH IMAGE x
[116] WRITE "2. TIME AND COST OF SHIP IN PORT" TO RESULT WITH IMAGE
             xxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
[117] WRITE " " TO RESULT WITH IMAGE x
[118] WRITE "TYPE WAITING UN+MOORING UNLOADING  LOADING   IDLE   PORT   COST"
        TO RESULT WITH IMAGE
             xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
[119] WRITE "     TIME     TIME     TIME      TIME    TIME    TIME     "
         TO RESULT WITH IMAGE
              xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
[120] WRITE "     (HRS)    (HRS)    (HRS)     (HRS)   (HRS)   (HRS)   (US$)"
        TO RESULT WITH IMAGE
             xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
[121] FOR O ← 1 TO TOTSHIPTYPE
[122]     WRITE " " TO RESULT WITH IMAGE x
[123]     WRITE "SAMUDRA" TO RESULT WITH IMAGE xxxxxxx IF O = 1
[124]     WRITE "NUSANTARA" TO RESULT WITH IMAGE xxxxxxxxx IF O = 2
[125]     WRITE "LOKAL" TO RESULT WITH IMAGE xxxxx IF O = 3
[126]     WRITE "KHUSUS" TO RESULT WITH IMAGE xxxxxx IF O = 4
[127]     WRITE "SHUTTLE" TO RESULT WITH IMAGE xxxxxxx IF O = 5
[128]     WRITE "RBARGE" TO RESULT WITH IMAGE xxxxxx IF O = 6
[129]     WRITE TWT[O]÷TNO[O];TMU[O]÷TNO[O];TUT[O]÷TNO[O];TLT[O]÷TNO[O];
              TIT[O]÷TNO[O];TPT[O]÷TNO[O];TCO[O]÷TNO[O] TO RESULT WITH IMAGE
            xxxxxx.xx*xxxxxx.xx*xxxxxx.xx*xxxxxxx.xx*xxxxx.xx*xxxx.xx*xxxxx.xx
[130] END
[131] WRITE " " TO RESULT WITH IMAGE x
[132] WRITE " " TO RESULT WITH IMAGE x
[133] WRITE "3. ROUTING OF CARGO THROUGH STORAGE FACILITIES" TO RESULT WITH
      IMAGE  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
[134] WRITE " " TO RESULT WITH IMAGE x
[135] WRITE "  CARGO          VIA SHED(TONS)               VIA YARD(TONS)" TO
        RESULT WITH IMAGE
            xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
[136] WRITE "               OUTBOUND  INBOUND   TOTAL   OUTBOUND INBOUND   TOTAL"
        TO RESULT WITH IMAGE
            xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
[137] FOR P ← 1 TO 3
[138]    WRITE "NCC   INT" TO RESULT WITH IMAGE xxxxxxxxx IF P = 1
[139]    WRITE "NCC   DOM" TO RESULT WITH IMAGE xxxxxxxxx IF P = 2
[140]    WRITE "CONTAINER" TO RESULT WITH IMAGE xxxxxxxxx IF P = 3
[141]    WRITE VIASHED[1,P]×SR÷K;VIASHED[2,P]×SR÷K;(SR÷K)×VIASHED[1,P]+
         VIASHED[2,P];VIAYARD[1,P]×SR÷K;VIAYARD[2,P]×SR÷K;(SR÷K)×VIAYARD[1,P]+
          VIAYARD[2,P] TO RESULT WITH IMAGE
         xxxxxxxxxxxxxxx.xx*xxxxx.xx*xxxxx.xx*xxxxxx.xx*xxxxx.xx*xxxxx.xx
[142] END
[143] WRITE " " TO RESULT WITH IMAGE x
[144] WRITE " " TO RESULT WITH IMAGE x
[145] WRITE "4. NUMBER OF SHIPS WHICH STOP CARGO HANDLING" TO RESULT WITH IMAGE
            xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
[146] WRITE " " TO RESULT WITH IMAGE x
[147] WRITE "TIMES    SAMUDRA  NUSANTARA  LOKAL   KHUSUS  RBARGE" TO RESULT
      WITH IMAGE        xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
[148] WRITE " " TO RESULT WITH IMAGE x
[149] WRITE "  1   ";NSS[1,1]×SR÷K;NSS[2,1]×SR÷K;NSS[3,1]×SR÷K;NSS[4,1]×SR÷K;
                 NSS[6,1]×SR÷K TO RESULT WITH IMAGE
            xxxxx*xxxxxxxx*xxxxxxxxx*xxxxxxxx*xxxxxxxx*xxxxxxx
[150] WRITE " 22  ";NSS[1,2]×SR÷K;NSS[2,2]×SR÷K;NSS[3,2]×SR÷K;NSS[4,2]×SR÷K;
                NSS[6,2]×SR÷K TO RESULT WITH IMAGE
           xxxxx*xxxxxxxx*xxxxxxxxx*xxxxxxxx*xxxxxxxx*xxxxxxx
[151] WRITE " " TO RESULT WITH IMAGE x
[152] WRITE " " TO RESULT WITH IMAGE x
[153] WRITE "5. NUMBER OF SHIPS WHICH BERTH NOT AT PREFERRED QUAY" TO RESULT
        WITH IMAGE xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
[154] WRITE " " TO RESULT WITH IMAGE x
[155] WRITE "SAMUDRA KHUSUSINT SHUTTLE  RBARGE  NUSANTARA  LOKAL  KHUSUSDOM" TO
        RESULT WITH IMAGE
           xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
[156] WRITE " " TO RESULT WITH IMAGE x
[157] WRITE NSD[1]×SR÷K;NSD[4]×SR÷K;NSD[5]×SR÷K;NSD[6]×SR÷K;NSD[2]×SR÷K;NSD[3]×
        SR÷K;NSD[7]×SR÷K TO RESULT WITH IMAGE
           xxxxx*xxxxxxxxx*xxxxxxx*xxxxxxx*xxxxxxxxx*xxxxxx*xxxxxxxx
[158] CANCEL ALL
[159] PRINT STATISTICS
[160] TERMINATE
```

MODEL   MPTSIM
MOD   GENERATORMOD

```
[0]    ⍝ PROCESS OF SHIPGENERATOR
[1]
[2]    GENSTART:
[3]    GENINTARR ← INTARR[NOGEN]
[4]
[5]    IF (GENTYPE="SHUTTLE")∨GENTYPE="RBARGE"
[6]        GENLENGTH ← SLENGTH[NOGEN-5]
[7]        GENCARGO  ← SCARGO[NOGEN-5]
[8]    END
[9]    IF GENTYPE ="SAMUDRA"
[10]     GENRANDOM ← CEIL(UNIF[NOGEN])
[11]     IF GENRANDOM ≤ 20
[12]        GENLENGTH ← 35 + 0.26316×GENRANDOM-1
[13]        GENCARGO  ← MEANCARGO×0.2+0.0210526×GENRANDOM-1
[14]     END
[15]     IF GENRANDOM > 20
[16]       IF GENRANDOM ≤ 50
[17]          GENLENGTH ← 40 + 0.3448275×GENRANDOM-21
[18]          GENCARGO  ← MEANCARGO×0.2+0.0241379×GENRANDOM-21
[19]       END
[20]       IF GENRANDOM > 50
[21]          IF GENRANDOM ≤ 60
[22]             GENLENGTH ← 50 + 1.1111111×GENRANDOM-51
[23]             GENCARGO  ← MEANCARGO×0.2+0.1333333×GENRANDOM-51
[24]          END
[25]          IF GENRANDOM > 60
[26]             IF GENRANDOM ≤ 76
[27]                GENLENGTH ← 60 + 1.3333333×GENRANDOM-61
[28]                GENCARGO  ← MEANCARGO×0.2+0.12×GENRANDOM-61
[29]             END
[30]             IF GENRANDOM > 76
[31]                IF GENRANDOM ≤ 88
[32]                   GENLENGTH ← 80 + 2.7272727×GENRANDOM-77
[33]                   GENCARGO  ← MEANCARGO×0.2+0.3181818×GENRANDOM-77
[34]                END
[35]                IF GENRANDOM > 88
[36]                   GENLENGTH ← 110 +3.6363636×GENRANDOM-89
[37]                   GENCARGO  ← MEANCARGO×0.2+0.36363636×GENRANDOM-89
[38]                END
[39]             END
[40]          END
[41]       END
[42]    END
[43]  END
[44]  IF GENTYPE ="NUSANTARA"
[45]     GENRANDOM ← CEIL(UNIF[NOGEN])
[46]     IF GENRANDOM ≤ 45
[47]        GENLENGTH ← 30 + 0.2272727×GENRANDOM-1
[48]        GENCARGO  ← MEANCARGO×0.3+0.01363636×GENRANDOM-1
[49]     END
[50]     IF GENRANDOM > 45
[51]        IF GENRANDOM ≤ 70
[52]           GENLENGTH ← 40 + 0.4166666×GENRANDOM-46
[53]           GENCARGO  ← MEANCARGO×0.3+0.05×GENRANDOM-46
[54]        END
[55]        IF GENRANDOM > 70
[56]           IF GENRANDOM ≤ 85
[57]              GENLENGTH ← 50 + 0.71428×GENRANDOM-71
[58]              GENCARGO  ← MEANCARGO×0.3+0.15714×GENRANDOM-71
[59]           END
```

```
        IF GENRANDOM > 85
           IF GENRANDOM ≤ 93
              GENLENGTH ← 60 + 1.4286×GENRANDOM-86
              GENCARGO  ← MEANCARGO×0.3+0.3714×GENRANDOM-86
           END
           IF GENRANDOM > 93
              IF GENRANDOM ≤ 97
                 GENLENGTH ← 70 +3.3333×GENRANDOM-94
                 GENCARGO  ← MEANCARGO×0.3+1.2×GENRANDOM-94
              END
              IF GENRANDOM > 97
                 GENLENGTH ← 80 +10×GENRANDOM-98
                 GENCARGO  ← MEANCARGO×0.3+2.8×GENRANDOM-98
              END
           END
        END
     END
  END
END
IF GENTYPE ="LOKAL"
   GENRANDOM ← CEIL(UNIF[NOGEN])
   IF GENRANDOM ≤ 75
      GENLENGTH ← 25 + 0.0675675×GENRANDOM-1
      GENCARGO  ← MEANCARGO×0.60 + 0.00810810B×GENRANDOM-1
   END
   IF GENRANDOM > 75
      IF GENRANDOM ≤ 90
         GENLENGTH ← 30 +0.7142857×GENRANDOM-76
         GENCARGO  ← MEANCARGO×0.8+0.0428571×GENRANDOM-76
      END
      IF GENRANDOM > 90
         IF GENRANDOM ≤ 97
            GENLENGTH ← 41.67 +1.66667×GENRANDOM-91
            GENCARGO  ← MEANCARGO×1+0.166666666×GENRANDOM-91
         END
         IF GENRANDOM > 97
            GENLENGTH ← 55 + 10×GENRANDOM-98
            GENCARGO  ← MEANCARGO×1+1.000×GENRANDOM-98
         END
      END
   END
END
IF (GENTYPE="KHUSUSINT")∨GENTYPE="KHUSUSDOM"
GENRANDOM ← CEIL(UNIF[10])
   IF GENRANDOM ≤ 20
      GENLENGTH ← 30 +0.5263157×GENRANDOM-1
      GENCARGO  ← MEANCARGO × 0.2+0.0105263×GENRANDOM-1
   END
   IF GENRANDOM > 20
      IF GENRANDOM ≤ 55
         GENLENGTH ← 40 +0.2941176×GENRANDOM-21
         GENCARGO  ← MEANCARGO×0.2+0.0235294×GENRANDOM-21
      END
      IF GENRANDOM > 55
         IF GENRANDOM ≤ 70
            GENLENGTH ← 50 +2.1428571×GENRANDOM-56
            GENCARGO  ← MEANCARGO×0.2+0.1142857×GENRANDOM-56
         END
         IF GENRANDOM > 70
            IF GENRANDOM ≤ 90
               GENLENGTH ← 80 +1.0526316×GENRANDOM-71
               GENCARGO  ← MEANCARGO×0.2+0.1473684×GENRANDOM-71
            END
            IF GENRANDOM > 90
               GENLENGTH ← 100 + 2.2222222×GENRANDOM-91
               GENCARGO  ← MEANCARGO×0.2+0.53333333×GENRANDOM-91
            END
         END
      END
   END
END

THIS SHIP ← NEW SHIP
SHIPTYPE ← GENTYPE
SN  ← GENNO                    ⍝ SHIPNUMBERA
SHIPTRADE ← GENTRADE
SHIPPRIORITY ← GENPRIOR
SHIPLENGTH ← GENLENGTH
SHIPCARGO  ← GENCARGO
REQUAYLENGTH ← SHIPLENGTH OF THIS SHIP + 5.0 IF YEARRUN = 1986
REQUAYLENGTH ← SHIPLENGTH OF THIS SHIP × 1.10 IF YEARRUN ≠ 1986
SHIPCOST ← (6.25 × SHIPLENGTH OF THIS SHIP)-345.0 IF GENTYPE ="SHUTTLE"
SHIPCOST ← (3.10 × SHIPLENGTH OF THIS SHIP)-74.0 IF (GENTYPE ≠"SHUTTLE")∧
                 SHIPLENGTH OF THIS SHIP ≤ 60.0
SHIPCOST ← (2.20 × SHIPLENGTH OF THIS SHIP)-20.0 IF (GENTYPE ≠"SHUTTLE")∧
                (SHIPLENGTH OF THIS SHIP > 60.0) ∧
                 SHIPLENGTH OF THIS SHIP  < 100.0
SHIPCOST ← (6.70 × SHIPLENGTH OF THIS SHIP)-470.0 IF (GENTYPE ≠"SHUTTLE")∧
                 SHIPLENGTH OF THIS SHIP  ≥ 100.0
SHIPCOST ← 5.0 IF GENTYPE ="RBARGE"
SHIPINBOUNDCARGO ← GENINBOUND × SHIPCARGO OF THIS SHIP
SHIPOUTBOUNDCARGO ←SHIPCARGO OF THIS SHIP-SHIPINBOUNDCARGO OF THIS SHIP
INBOUNDCARGO ← SHIPINBOUNDCARGO OF THIS SHIP
OUTBOUNDCARGO← SHIPOUTBOUNDCARGO OF THIS SHIP
INCONTAINER ← GENINCONTAINER
OUTCONTAINER ← GENOUTCONTAINER
IF GENTYPE ="SHUTTLE"
   REQUAYCRANE ← 0
   SHIPCRANE ← 3
END
IF GENTYPE ="SAMUDRA"
   REQUAYCRANE ← 0
   SHIPCRANE ← 2
END
IF GENTYPE ="NUSANTARA"
   REQUAYCRANE ← 0
   SHIPCRANE ← 2
END
IF GENTYPE ="LOKAL"
   REQUAYCRANE ← 0
   SHIPCRANE ← 1
END
IF GENTYPE ="KHUSUSINT"
   REQUAYCRANE ← 0
   SHIPCRANE ← 3
END
IF GENTYPE ="KHUSUSDOM"
   REQUAYCRANE ← 0
   SHIPCRANE ← 3
END
IF GENTYPE ="RBARGE"
   REQUAYCRANE ← 1
   SHIPCRANE ← 0
END
MOORINGTIME ← GENMOOR
UNMOORINGTIME ← GENUNMOOR
LOADINGTIME ← 0.0
UNLOADINGTIME ← 0.0
WORKINGHOUR ←  GENWORKHOUR
EFFWORKING ← GENEFFWORK
CARGOHANDLING ← "NYET"
CARGOUT  ← CARGOSENDER
CARGOIN  ← CARGORECEIVER
CRANEPLANNER ← CRANEALLOCATION
HANDLINGRATE ←(GENCONT×GENCONTRATE)+(GENPALL×GENPALLRATE)+(GENBULK×
              GENBULKRATE)+(GENBAGS×GENBAGSRATE)+GENOTHER × GENOTHERATE
NORMBERTHINGTIME ← MOORINGTIME OF THIS SHIP + UNMOORINGTIME OF THIS SHIP+
                   (24÷WORKINGHOUR OF THIS SHIP×EFFWORKING OF THIS SHIP) ×
                   SHIPCARGO OF THIS SHIP÷HANDLINGRATE OF THIS SHIP ×
                   SHIPCRANE OF THIS SHIP + REQUAYCRANE OF THIS SHIP
NCCINSHED ← GNCCINSHED
NCCINYARD ← GNCCINYARD
NCOUTSHED ← GNCOUTSHED
NCOUTYARD ← GNCOUTYARD
CONINSHED ← GCONINSHED
CONINYARD ← GCONINYARD
COOUTSHED ← GCOOUTSHED
COOUTYARD ← GCOOUTYARD
ACTIVATE THIS SHIP FROM SHIPSTART IN SHIPMOD
WAIT GENINTARR
REPEAT FROM GENSTART
```

MODEL   MPTSIM
MOD   SHIPMOD

```
a PROCESS OF SHIP

SHIPSTART :
ENTER PREARRIVAL
IF (SHIPTYPE ≠"KHUSUSINT")^(SHIPTYPE≠"KHUSUSDOM")^SHIPTYPE≠"RBARGE"
   CALL CARGOUT
END
WAIT 30.0 DAYS
LEAVE PREARRIVAL
ARRIVALATPORT OF THIS SHIP  ← NOW
WAITINGLINE :
ENTER WAITINGROW
ENTER SHUTTLESET IF SHIPPRIORITY = 5
ENTER NONSHUTTLESET IF SHIPPRIORITY ≠ 5
STARTWAITING[SHIPPRIORITY] OF THIS SHIP ← NOW IF SHIPTYPE ≠ "SHUTTLE"
STARTWAITING[1] OF THIS SHIP ← NOW IF SHIPTYPE = "SHUTTLE"
ACTIVATE PORTADM FROM PASTART IN PORTADMMOD IF PORTADM IS NOT ACTIVE
PASSIVATE
BERTHING:
IF REQUAYCRANE > 0
   ENTER CRANESHIPSET
   CALL CRANEPLANNER
   PASSIVATE IF (SHIPCRANE + ADQUAYCRANE) = 0
END
ENTER QUAY[SUBTERMINAL]
ENDWAITING[SHIPPRIORITY] OF THIS SHIP ← NOW IF SHIPTYPE ≠"SHUTTLE"
ENDWAITING[1] OF THIS SHIP ← NOW IF SHIPTYPE ="SHUTTLE"
ENTER MAYSTOPSHIPSET IF (SUBTERMINAL = 1)^SHIPPRIORITY<5
WAIT MOORINGTIME
WHILE INBOUNDCARGO > 0.0
 IF CARGOHANDLING ="STOP"
   FREEQUAYCRANE ← FREEQUAYCRANE + ADQUAYCRANE
   LEAVE CRANESHIPSET IF REQUAYCRANE > 0
   CALL CRANEPLANNER  IF REQUAYCRANE > 0
   WAIT UNMOORINGTIME
   LEAVE QUAY[SUBTERMINAL]
   FREEQUAY[SUBTERMINAL] ← FREEQUAY[SUBTERMINAL]+REQUAYLENGTH
   LEAVE MAYSTOPSHIPSET IF (SUBTERMINAL=1)^SHIPPRIORITY<5
   SHIPPRIORITY OF THIS SHIP← SHIPPRIORITY OF THIS SHIP + 1
   CARGOHANDLING OF THIS SHIP ← "NEXT"
   REPEAT FROM WAITINGLINE
 END
 DATE OF THIS SHIP ← NOW ÷ 24.0
 TIME OF THIS SHIP ← NOW - 24.0 × FLOOR(DATE)
 WAIT 24.0 - TIME IF TIME  > WORKINGHOUR × EFFWORKING
 UNLOADINGPERHOUR OF THIS SHIP ← HANDLINGRATE × SHIPCRANE+ADQUAYCRANE
 INBOUNDCARGO OF THIS SHIP←INBOUNDCARGO-UNLOADINGPERHOUR
 CARGOINSHED[SHIPTRADE] ← CARGOINSHED[SHIPTRADE] + UNLOADINGPERHOUR ×
                             NCCINSHED × 1.0 - INCONTAINER
 CARGOINYARD[SHIPTRADE] ← CARGOINYARD[SHIPTRADE] + UNLOADINGPERHOUR ×
                             NCCINYARD × 1.0 - INCONTAINER
 CARGOINSHED[3]←CARGOINSHED[3]+UNLOADINGPERHOUR×CONINSHED×INCONTAINER
 CARGOINYARD[3]←CARGOINYARD[3]+UNLOADINGPERHOUR×CONINYARD×INCONTAINER
 WAIT 1.0
 UNLOADINGTIME OF THIS SHIP ← UNLOADINGTIME OF THIS SHIP + 1.0
END
IF INBOUNDCARGO < 0.0
   CARGOINSHED[SHIPTRADE] ← CARGOINSHED[SHIPTRADE] + INBOUNDCARGO ×
                             NCCINSHED × 1.0 - INCONTAINER
   CARGOINYARD[SHIPTRADE] ← CARGOINYARD[SHIPTRADE] + INBOUNDCARGO ×
                             NCCINYARD × 1.0 - INCONTAINER
   CARGOINSHED[3]←CARGOINSHED[3]+INBOUNDCARGO×CONINSHED×INCONTAINER
   CARGOINYARD[3]←CARGOINYARD[3]+INBOUNDCARGO×CONINYARD×INCONTAINER
END

WHILE OUTBOUNDCARGO > 0.0
 IF CARGOHANDLING ="STOP"
    FREEQUAYCRANE ← FREEQUAYCRANE + ADQUAYCRANE
    LEAVE CRANESHIPSET IF REQUAYCRANE > 0
    CALL CRANEPLANNER  IF REQUAYCRANE > 0
    WAIT UNMOORINGTIME
    LEAVE QUAY[SUBTERMINAL]
    FREEQUAY[SUBTERMINAL] ← FREEQUAY[SUBTERMINAL]+REQUAYLENGTH
    LEAVE MAYSTOPSHIPSET IF (SUBTERMINAL=1)^SHIPPRIORITY<5
    SHIPPRIORITY OF THIS SHIP← SHIPPRIORITY OF THIS SHIP+ 1
    CARGOHANDLING OF THIS SHIP ← "NEXT"
    REPEAT FROM WAITINGLINE
 END
 DATE OF THIS SHIP ← NOW ÷ 24.0
 TIME OF THIS SHIP ← NOW - 24.0 × FLOOR(DATE)
 WAIT 24.0 - TIME IF TIME > WORKINGHOUR × EFFWORKING
 LOADINGPERHOUR OF THIS SHIP ← HANDLINGRATE × SHIPCRANE+ADQUAYCRANE
 OUTBOUNDCARGO OF THIS SHIP ← OUTBOUNDCARGO-LOADINGPERHOUR
 CARGOINSHED[SHIPTRADE] ← CARGOINSHED[SHIPTRADE] - LOADINGPERHOUR ×
                             NCOUTSHED × 1.0 - OUTCONTAINER
 CARGOINYARD[SHIPTRADE] ← CARGOINYARD[SHIPTRADE] - LOADINGPERHOUR ×
                             NCOUTYARD × 1.0 - OUTCONTAINER
 CARGOINSHED[3]←CARGOINSHED[3]-LOADINGPERHOUR×COOUTSHED×OUTCONTAINER
 CARGOINYARD[3]←CARGOINYARD[3]-LOADINGPERHOUR×COOUTYARD×OUTCONTAINER
 WAIT 1.0
 LOADINGTIME OF THIS SHIP ← LOADINGTIME OF THIS SHIP + 1.0
END
CARGOINSHED[SHIPTRADE] ← CARGOINSHED[SHIPTRADE] - OUTBOUNDCARGO ×
                             NCOUTSHED × 1.0 - OUTCONTAINER
CARGOINYARD[SHIPTRADE] ← CARGOINYARD[SHIPTRADE] - OUTBOUNDCARGO ×
                             NCOUTYARD × 1.0 - OUTCONTAINER
CARGOINSHED[3]←CARGOINSHED[3]-OUTBOUNDCARGO×COOUTSHED×OUTCONTAINER
CARGOINYARD[3]←CARGOINYARD[3]-OUTBOUNDCARGO×COOUTYARD×OUTCONTAINER
CALL CARGOIN
FREEQUAYCRANE ← FREEQUAYCRANE + ADQUAYCRANE
LEAVE CRANESHIPSET IF REQUAYCRANE > 0
CALL CRANEPLANNER  IF REQUAYCRANE > 0
WAIT UNMOORINGTIME
LEAVE QUAY[SUBTERMINAL]
FREEQUAY[SUBTERMINAL] ← FREEQUAY[SUBTERMINAL] + REQUAYLENGTH
LEAVE MAYSTOPSHIPSET IF (SUBTERMINAL=1)^SHIPPRIORITY<5
ACTIVATE PORTADM FROM PASTART IN PORTADMMOD IF PORTADM IS NOT ACTIVE


WAITINGTIME OF THIS SHIP← ENDWAITING[1] - STARTWAITING[1]
                         IF (SHIPPRIORITY = 1) ∨ SHIPPRIORITY = 5
IF (SHIPPRIORITY ≠ 1) ^ SHIPPRIORITY ≠ 5
  FOR  G ← 1 TO SHIPPRIORITY
     WAITINGTIME OF THIS SHIP ← WAITINGTIME + ENDWAITING[G] -
                                             STARTWAITING[G]
  END
  MOORINGTIME OF THIS SHIP← (SHIPPRIORITY - 1) × MOORINGTIME
  UNMOORINGTIME OF THIS SHIP←(SHIPPRIORITY - 1) × UNMOORINGTIME
END
IDLETIME OF THIS SHIP ← NOW - ARRIVALATPORT + WAITINGTIME +
       MOORINGTIME + UNLOADINGTIME + LOADINGTIME + UNMOORINGTIME

IF NOW > RUNINTIME DAYS
  K ← CEIL((NOW- RUNINTIME DAYS)÷ SUBRUNTIME DAYS)
  NO[SN,K] ← NO[SN,K] + 1
  SL[SN,K] ← SL[SN,K] + SHIPLENGTH
  SC[SN,K] ← SC[SN,K] + SHIPCARGO
  BT[SN,K] ← BT[SN,K] ← NOW - ARRIVALATPORT + WAITINGTIME
  BO[SN,K] ← BO[SN,K] + (REQUAYLENGTH × NOW - ARRIVALATPORT +
             WAITINGTIME)÷365.0 DAYS × INTQUAYLENGTH + DOMQUAYLENGTH
  TWT[SN]  ← TWT[SN] + WAITINGTIME
  TMU[SN]  ← TMU[SN] + MOORINGTIME + UNMOORINGTIME
  TUT[SN]  ← TUT[SN] + UNLOADINGTIME
  TLT[SN]  ← TLT[SN] + LOADINGTIME
  TIT[SN]  ← TIT[SN] + IDLETIME
  TPT[SN]  ← TPT[SN] + NOW - ARRIVALATPORT
  TCO[SN]  ← TCO[SN] + SHIPCOST × NOW - ARRIVALATPORT

  NSS[SN,1] ← NSS[SN,1] + 1 IF (CARGOHANDLING="NEXT")^SHIPPRIORITY=2
  NSS[SN,2] ← NSS[SN,2] + 1 IF (CARGOHANDLING="NEXT")^SHIPPRIORITY=3

  IF SHIPTRADE ≠ SUBTERMINAL
    NSD[SN] ← NSD[SN] + 1 IF SHIPTYPE ≠ "KHUSUSDOM"
    NSD[7]  ← NSD[7]  + 1 IF SHIPTYPE = "KHUSUSDOM"
  END
END
TERMINATE
```

58

MODEL MPTSIM
MAC CARGOSENDER

```
IF (OUTCONTAINER > 0.0) ^ COOUTSHED > 0.0
   THIS CARGO ← NEW CARGO
   RANDOMDT ← CEIL(UNIF[11])
   DWELLTIME ← 3.0 DAYS IF RANDOMDT ≤ 25
   DWELLTIME ← 6.0 DAYS IF (RANDOMDT > 25)^RANDOMDT≤75
   DWELLTIME ← 9.0 DAYS IF RANDOMDT > 75
   STARTSTORAGE ← NOW+30.0 DAYS+MOORINGTIME+NORMBERTHINGTIME-DWELLTIME
   AMOUNT ← SHIPOUTBOUNDCARGO × COOUTSHED × OUTCONTAINER
   ROUTE ← 3
   ACTIVATE THIS CARGO FROM STORESHED IN STORAGEMOD
END
THIS CARGO ← NEW CARGO
IF SHIPTRADE = 1
   RANDOMDT ← CEIL(UNIF[12])
   DWELLTIME ← 1.0 DAY IF RANDOMDT ≤ 15
   DWELLTIME ← 3.0 DAYS IF (RANDOMDT > 15)^ RANDOMDT ≤ 45
   DWELLTIME ← 5.0 DAYS IF (RANDOMDT > 45)^ RANDOMDT ≤ 85
   DWELLTIME ← 7.0 DAYS IF (RANDOMDT > 85)^ RANDOMDT ≤ 95
   DWELLTIME ← 9.0 DAYS IF RANDOMDT > 95
END
IF SHIPTRADE = 2
   RANDOMDT ← CEIL(UNIF[13])
   DWELLTIME ← 3.0 DAYS IF RANDOMDT ≤ 50
   DWELLTIME ← 5.0 DAYS IF (RANDOMDT > 50)^ RANDOMDT ≤ 80
   DWELLTIME ← 7.0 DAYS IF (RANDOMDT ≥ 80)^ RANDOMDT ≤ 90
   DWELLTIME ← 11.0 DAYS IF RANDOMDT > 90
END
AMOUNT ← SHIPOUTBOUNDCARGO × NCOUTSHED × 1.0 - CUTCONTAINER
ROUTE ← SHIPTRADE
STARTSTORAGE ← NOW + 30 DAY + MOORINGTIME OF THIS SHIP +
               NORMBERTHINGTIME OF THIS SHIP - DWELLTIME OF THIS CARGO
ACTIVATE THIS CARGO FROM STORESHED IN STORAGEMOD
IF (OUTCONTAINER > 0.0) ^ COOUTYARD > 0.0
   THIS CARGO ← NEW CARGO
   RANDOMDT ← CEIL(UNIF[14])
   DWELLTIME ← 3.0 DAYS IF RANDOMDT ≤ 25
   DWELLTIME ← 6.0 DAYS IF (RANDOMDT> 25)^RANDOMDT≤75
   DWELLTIME ← 9.0 DAYS IF RANDOMDT > 75
   STARTSTORAGE ← NOW+30.0 DAYS+MOORINGTIME+NORMBERTHINGTIME-DWELLTIME
   ROUTE ← 3
   AMOUNT ← SHIPOUTBOUNDCARGO × COOUTYARD × OUTCONTAINER
   ACTIVATE THIS CARGO FROM STOREYARD IN STORAGEMOD
END
THIS CARGO ← NEW CARGO
IF SHIPTRADE = 1
   RANDOMDT ← CEIL(UNIF[15])
   DWELLTIME ← 10.5 DAYS IF RANDOMDT ≤ 65
   DWELLTIME ← 17.5 DAYS IF (RANDOMDT > 65)^ RANDOMDT ≤ 95
   DWELLTIME ← 24.5 DAYS IF RANDOMDT > 95
END
IF SHIPTRADE = 2
   RANDOMDT ← CEIL(UNIF[16])
   DWELLTIME ← 3.5 DAYS IF RANDOMDT ≤ 15
   DWELLTIME ← 10.5 DAYS IF (RANDOMDT > 15)^ RANDOMDT ≤ 60
   DWELLTIME ← 17.5 DAYS IF RANDOMDT > 60
END
AMOUNT ← SHIPOUTBOUNDCARGO × NCOUTYARD × 1 - OUTCONTAINER
ROUTE ← SHIPTRADE
STARTSTORAGE ← NOW + 30 DAY + MOORINGTIME OF THIS SHIP +
               NORMBERTHINGTIME OF THIS SHIP - DWELLTIME OF THIS CARGO
ACTIVATE THIS CARGO FROM STOREYARD IN STORAGEMOD
RETURN
```

MODEL MPTSIM
MAC CARGORECEIVER

```
IF (INCONTAINER > 0.0) ^ COINSHED > 0.0
   THIS CARGO ← NEW CARGO
   RANDOMDT ← CEIL(UNIF[17])
   DWELLTIME ← 5.0 DAYS IF RANDOMDT ≤ 25
   DWELLTIME ← 10.0 DAYS IF (RANDOMDT>25)^RANDOMDT≤75
   DWELLTIME ← 15.0 DAYS IF RANDOMDT>75
   STARTSTORAGE ← NOW + DWELLTIME - LOADINGTIME
   ROUTE ← 3
   AMOUNT ← SHIPINBOUNDCARGO × COINSHED × INCONTAINER
   ACTIVATE THIS CARGO FROM UNSTORESHED IN STORAGEMOD
END
THIS CARGO ← NEW CARGO
IF SHIPTRADE = 1
   RANDOMDT ← CEIL(UNIF[18])
   DWELLTIME ← 3.5 DAYS IF RANDOMDT ≤ 5
   DWELLTIME ← 10.5 DAYS IF (RANDOMDT >5)^ RANDOMDT≤ 35
   DWELLTIME ← 17.5 DAYS IF (RANDOMDT >35)^ RANDOMDT≤ 70
   DWELLTIME ← 24.5 DAYS IF RANDOMDT > 70
END
IF SHIPTRADE = 2
   RANDOMDT ← CEIL(UNIF[19])
   DWELLTIME ← 3.5 DAYS IF RANDOMDT ≤ 10
   DWELLTIME ← 10.5 DAYS IF (RANDOMDT >10)^ RANDOMDT≤ 50
   DWELLTIME ← 17.5 DAYS IF (RANDOMDT >50)^ RANDOMDT≤ 80
   DWELLTIME ← 24.5 DAYS IF (RANDOMDT >80)^ RANDOMDT≤ 95
   DWELLTIME ← 31.5 DAYS IF RANDOMDT > 95
END
AMOUNT ← SHIPINBOUNDCARGO × NCCINSHED × 1.0 - INCONTAINER
ROUTE ← SHIPTRADE
STARTSTORAGE ← NOW + DWELLTIME OF THIS CARGO - LOADINGTIME OF THIS SHIP
ACTIVATE THIS CARGO FROM UNSTORESHED IN STORAGEMOD
IF (INCONTAINER > 0.0) ^ COINYARD > 0.0
   THIS CARGO ← NEW CARGO
   RANDOMDT ← CEIL(UNIF[20])
   DWELLTIME ← 5.0 DAYS IF RANDOMDT ≤ 25
   DWELLTIME ← 10.0 DAYS IF (RANDOMDT>25)^RANDOMDT≤75
   DWELLTIME ← 15.0 DAYS IF RANDOMDT > 75
   STARTSTORAGE ← NOW + DWELLTIME - LOADINGTIME
   ROUTE ← 3
   AMOUNT ← SHIPINBOUNDCARGO × COINYARD × INCONTAINER
   ACTIVATE THIS CARGO FROM UNSTOREYARD IN STORAGEMOD
END
THIS CARGO ← NEW CARGO
IF SHIPTRADE = 1
   RANDOMDT ← CEIL(UNIF[21])
   DWELLTIME ← 10.5 DAYS IF RANDOMDT ≤ 65
   DWELLTIME ← 17.5 DAYS IF (RANDOMDT >65)^ RANDOMDT≤ 95
   DWELLTIME ← 24.5 DAYS IF RANDOMDT > 95
END
IF SHIPTRADE = 2
   RANDOMDT ← CEIL(UNIF[22])
   DWELLTIME ← 3.5 DAYS IF RANDOMDT ≤ 15
   DWELLTIME ← 10.5 DAYS IF (RANDOMDT >15)^ RANDOMDT≤ 60
   DWELLTIME ← 17.5 DAYS IF RANDOMDT > 60
END
AMOUNT ← SHIPINBOUNDCARGO × NCCINYARD × 1.0 - INCONTAINER
ROUTE ← SHIPTRADE
STARTSTORAGE ← NOW + DWELLTIME OF THIS CARGO - LOADINGTIME OF THIS SHIP
ACTIVATE THIS CARGO FROM UNSTOREYARD IN STORAGEMOD
RETURN
```

DATAFILE MINO50

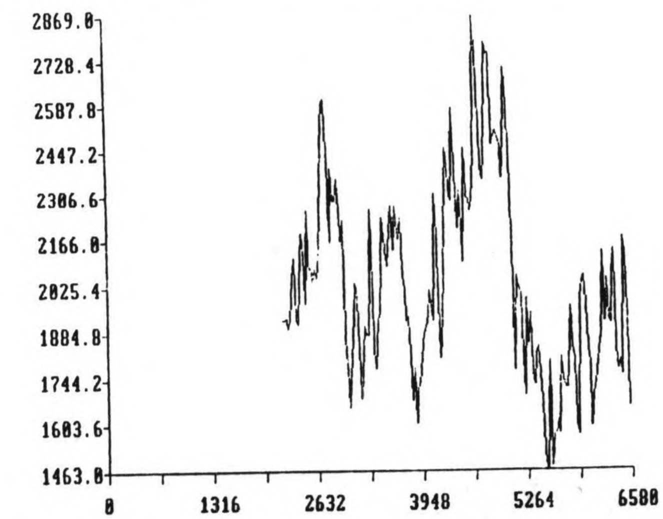
```
# DATA 2005 FOR EXPERIMENTATION RUN #

41   2005   273.75   91.25   4

360.0   375.0   3

7   6

"SAMUDRA"   1   1   1   78.2   0   580.0   0.48   0.54   0.54
0.54   0.40   0.06   0   0
31.0   26.0   19.5   0   0
0.29   0.26   0.17   0.14   0.60 0.10   0.45   0.10
2.0   2.0   9.0   0.90

"KHUSUSINT"  4   1   1   82.6   0   700.0   1.00 0 0
0   0   0   0   1.0
0   0   0   0   12.3
0   0.73   0   0 0 0 0 0
2.0   2.0   9.0   0.90

"NUSANTARA"  2   2   1   7.2   0   400.0   0.96 0 0
0   0   0.15   0.75   0.10
0   0   13   17.3   8.7
0.03   0.08   0.0   0.01   0 0 0 0
2.0   2.0   9.0   0.90

"LOKAL"   3   2   1   10.9   0   180.0   0.79 0 0
0   0   0.47   0.34   0.19
0   0   12.2   16.3   8.2
0.33   0.15   0.03   0.08   0 0 0 0
2.0   2.0   9.0   0.90

"KHUSUSDOM"  4   2   1   70.1   0   700.0   1.00 0 0
0   0   0   0.54   0.46
0   0   0   24.5   12.3
0   0.05   0   0 0 0 0 0
2.0   2.0   9.0   0.90


"SHUTTLE"  5   1   5   128.8 12.0 90.0 105.0 3400.0 5400.0 0.48 0.48 0.71
0.60   0.27   0.13   0   0
90.0   31.0   16.2   0   0
0.29   0.26   0.17   0.14   0.60   0.10   0.45   0.10
2.0   2.0   16.0   1.00


"RBARGE"   6   1   1   39.8   0   25.0   35.0   30.0   70.0   1.0   0 0
0   0   0   0   1.0
0   0   0   0   20.0
1.0   0   0   0   0 0 0 0
2.0   2.0   9.0   0.90
```

```
*** P E R S O N A L   P R O S I M ***                    MODEL MPTSIM   IS RUNNING


             NUMBER OF  ZERO    CURRENT  MAX.       INFORMATION ABOUT WAITINGTIMES
QUEUE NAME   ENTRIES  ENTRIES LENGTH  LENGTH         MEAN   DEVIATION   MAXIMUM
QUAY    2      946        0       5       9         39.96     23.62     238.00
QUAY    1      877        0       4      11         35.43     24.73     237.00
WAITINGROW    1623      253       0      52         55.19     51.01     168.66
PREARRIVAL    1981        0     232     252        720.00      0.00     720.00
HIT ANY KEY WHEN READY...
```

```
DATAFILE    MOUTO50

[0]
[1]  RESULT OF RUN NO :  41      YEAR :  2005
[2]
[3]  1. BERTH UTILIZATION
[4]
[5]  SHIPTYPE  NO  SHIPCALL  SHIPLENGTH  SHIPCARGO BERTHINGTIME  BOR
[6]                              (M)       (TON)      (HOURS)   (0/0)
[7]
[8]  SAMUDRA
[9]             1    120       68.60      666.94      33.78     5.77
[10]            2    128       66.07      434.47      22.27     4.16
[11]
[12]       AVERAGE
[13]                 124       67.33      550.71      28.03     4.96
[14]
[15] NUSANTARA
[16]            1   1128       45.59      388.16      39.13    39.72
[17]            2   1264       44.97      357.31      34.31    36.92
[18]
[19]       AVERAGE
[20]                1196       45.28      372.74      36.72    38.32
[21]
[22] LOKAL
[23]            1    808       31.03      183.08      41.80    19.24
[24]            2    776       30.13      173.98      37.00    15.49
[25]
[26]       AVERAGE
[27]                 792       30.58      178.53      39.40    17.36
[28]
[29] KHUSUS
[30]            1    232       63.98      723.98      45.61    15.79
[31]            2    256       59.88      734.33      45.75    15.84
[32]
[33]       AVERAGE
[34]                 244       61.93      729.15      45.68    15.82
[35]
[36] SHUTTLE
[37]            1     68       96.71     4294.90      35.76     4.04
[38]            2     64       98.65     4552.75      34.63     3.77
[39]
[40]       AVERAGE
[41]                  66       97.68     4423.83      35.20     3.90
[42]
[43] RBARGE
[44]            1    236       30.46       51.83      14.43     1.83
[45]            2    224       29.79       49.15      17.07     1.96
[46]
[47]       AVERAGE
[48]                 230       30.12       50.49      15.75     1.89
[49]
[50] SUBRUN      BERTH OCUPANCY RATIO OF MPT (0/0)
[51]  1                          86.38
[52]  2                          78.13
[53]
[54] AVERAGE                     82.26
[55]
[56]
```

```
[57]  2. TIME AND COST OF SHIP IN PORT
[58]
[59]  TYPE WAITING UN+MOORING UNLOADING LOADING  IDLE    PORT    COST
[60]        TIME      TIME      TIME      TIME    TIME    TIME
[61]        (HRS)     (HRS)     (HRS)     (HRS)   (HRS)   (HRS)   (US$)
[62]
[63]  SAMUDRA
[64]        69.61     4.00      4.63      5.03   14.18   97.45 16548.27
[65]
[66]  NUSANTARA
[67]        57.30     4.00     10.86      1.08   20.64   93.88  6671.97
[68]
[69]  LOKAL
[70]        62.34     4.00     10.31      3.10   22.03  101.79  2405.67
[71]
[72]  KHUSUS
[73]        66.42     4.00     16.27      0.00   25.41  112.10 15794.29
[74]
[75]  SHUTTLE
[76]         5.91     4.00     10.88     11.76    8.58   41.12 11045.29
[77]
[78]  RBARGE
[79]        62.00     4.00      3.03      0.00    8.68   77.72   388.59
[80]
[81]
[82]  3. ROUTING OF CARGO THROUGH STORAGE FACILITIES
[83]
[84]  CARGO          VIA SHED(TONS)                  VIA YARD(TONS)
[85]           OUTBOUND  INBOUND   TOTAL     OUTBOUND  INBOUND   TOTAL
[86]  NCC  INT
[87]           10239.08 37455.70 47694.78    8556.45 83934.35 92490.80
[88]  NCC  DOM
[89]             888.21 50759.11 51647.32    2533.82 56254.59 58788.41
[90]  CONTAINER
[91]           57326.57 52764.38 1.1009E5   12739.24  8794.06 21533.30
[92]
[93]
[94]  4. NUMBER OF SHIPS WHICH STOP CARGO HANDLING
[95]
[96]  TIMES   SAMUDRA  NUSANTARA  LOKAL   KHUSUS  RBARGE
[97]
[98]   1         6        36        36      18       4
[99]  22         0         0         0       0       0
[100]
[101]
[102] 5. NUMBER OF SHIPS WHICH BERTH NOT AT PREFERRED QUAY
[103]
[104] SAMUDRA KHUSUSINT SHUTTLE  RBARGE  NUSANTARA  LOKAL  KHUSUSDOM
[105]
[106]   46       32        0        68      482      298      48
```

=== PERSONAL PROSIM PLOT FACILITY === MODEL IS MPTSIM SELECTION IS A



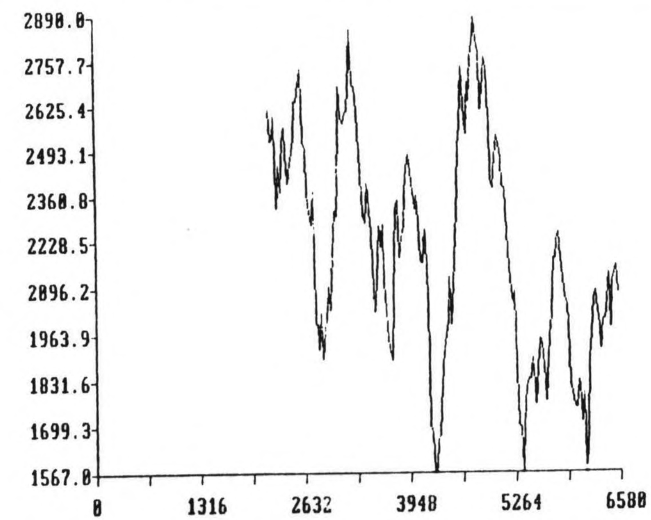
↓:ZOOM ←:LEFT →:RIGHT Home:RESHOW End:QUIT

=== PERSONAL PROSIM HISTOGRAM FACILITY === MODEL IS MPTSIM SELECTION IS A

MEAN : 2045.517334 MINIMUM: 1463.779907
DEVIATION: 294.685638 MAXIMUM: 2868.312012

UPPER BOUND	CUM PERC	183 ENTRIES
1546.779907	2.2	4
1629.779907	6.6	8
1712.779907	10.4	7
1795.779907	19.7	17
1878.779907	32.2	23
1961.779907	45.4	24
2044.779907	54.6	17
2127.779785	62.3	14
2210.779785	71.0	16
2293.779785	79.8	16
2376.779785	85.2	10
2459.779785	89.6	8
2542.779785	94.5	9
2625.779785	96.7	4
2708.779785	97.3	1
2791.779785	99.5	4
2874.779785	100.0	1

=== PERSONAL PROSIM PLOT FACILITY === MODEL IS MPTSIM SELECTION IS B

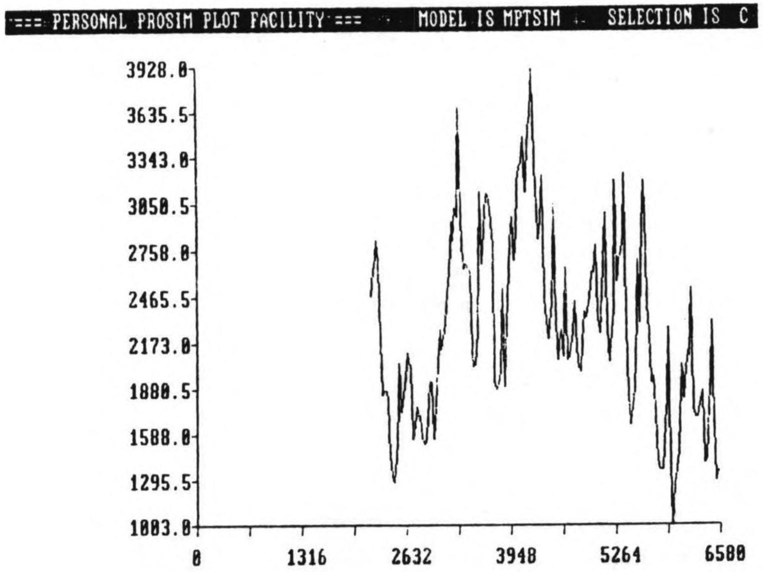


↓:ZOOM ←:LEFT →:RIGHT Home:RESHOW End:QUIT

=== PERSONAL PROSIM HISTOGRAM FACILITY === MODEL IS MPTSIM SELECTION IS B

MEAN : 2218.040527 MINIMUM: 1567.851196
DEVIATION: 321.195801 MAXIMUM: 2889.418213

UPPER BOUND	CUM PERC	183 ENTRIES
1645.851196	2.2	4
1723.851196	7.1	9
1801.851196	10.4	6
1879.851196	16.9	12
1957.851196	22.4	10
2035.851196	32.8	19
2113.851074	41.5	16
2191.851074	49.7	15
2269.851074	55.2	10
2347.851074	62.8	14
2425.851074	70.5	14
2503.851074	77.0	12
2581.851074	84.2	13
2659.851074	90.7	12
2737.851074	94.0	6
2815.851074	98.4	8
2893.851074	100.0	3

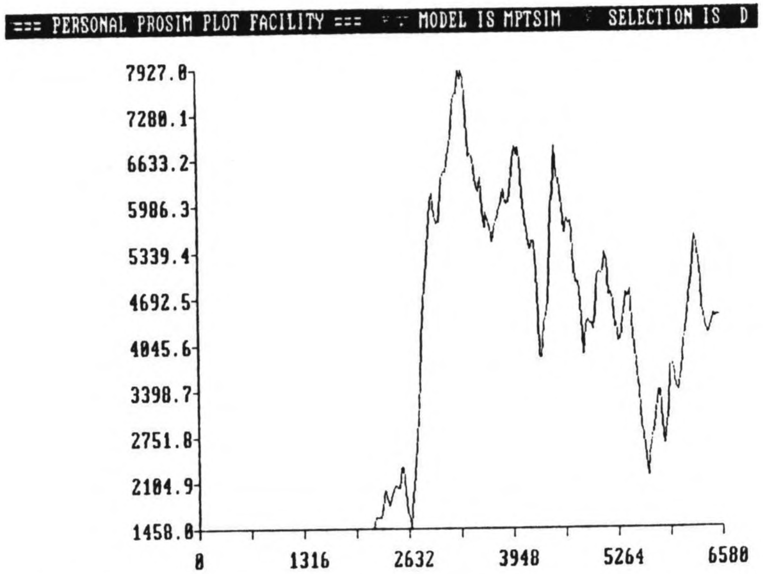


↓:ZOOM ←:LEFT →:RIGHT Home:RESHOW End:QUIT

=== PERSONAL PROSIM HISTOGRAM FACILITY === MODEL IS MPTSIM SELECTION IS C

MEAN : 2279.833008 MINIMUM: 1003.481995
DEVIATION: 577.938110 MAXIMUM: 3927.695068

UPPER BOUND	CUM PERC	183 ENTRIES
1176.481934	0.5	1
1349.481934	2.7	4
1522.481934	8.7	11
1695.481934	14.8	11
1868.481934	26.2	21
2041.481934	37.2	20
2214.481934	49.2	22
2387.481934	61.2	22
2560.481934	67.8	12
2733.481934	77.0	17
2906.481934	83.6	12
3079.481934	90.2	12
3252.481934	95.1	9
3425.481934	97.3	4
3598.481934	98.4	2
3771.481934	99.5	2
3944.481934	100.0	1



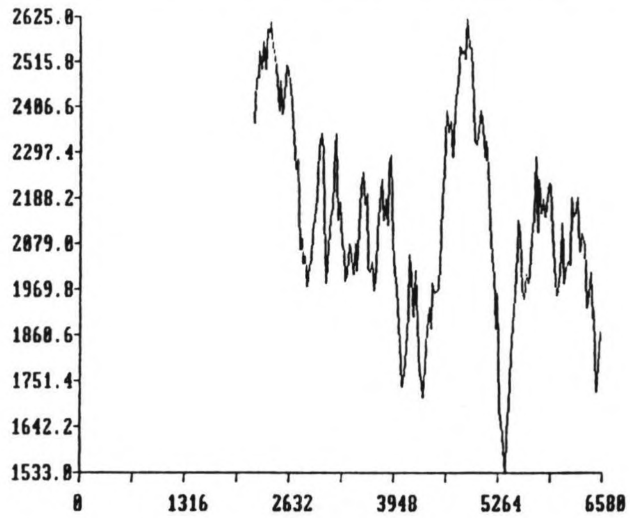
↓:ZOOM ←:LEFT →:RIGHT Home:RESHOW End:QUIT

=== PERSONAL PROSIM HISTOGRAM FACILITY === MODEL IS MPTSIM SELECTION IS D

MEAN : 4682.683105 MINIMUM: 1458.777344
DEVIATION: 1607.674561 MAXIMUM: 7926.294922

UPPER BOUND	CUM PERC	183 ENTRIES
1839.777344	6.0	11
2220.777344	10.9	9
2601.777344	14.2	6
2982.777344	18.6	8
3363.777344	20.8	4
3744.777344	26.2	10
4125.777344	31.1	9
4506.777344	45.4	26
4887.777344	52.5	13
5268.777344	60.1	14
5649.777344	67.2	13
6030.777344	78.1	20
6411.777344	87.4	17
6792.777344	92.9	10
7173.777344	95.6	5
7554.777344	96.7	2
7935.777344	100.0	6

=== PERSONAL PROSIM PLOT FACILITY === MODEL IS MPTSIM SELECTION IS E



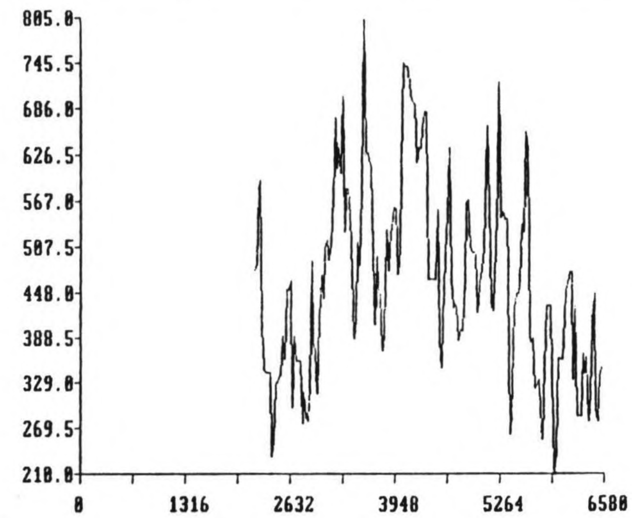
↓:ZOOM ←:LEFT →:RIGHT Home:RESHOW End:QUIT

=== PERSONAL PROSIM HISTOGRAM FACILITY === MODEL IS MPTSIM SELECTION IS E

MEAN : 2138.924561 MINIMUM: 1533.214722
DEVIATION: 232.660049 MAXIMUM: 2624.539307

UPPER BOUND	CUM PERC	183 ENTRIES
1598.214722	1.1	2
1663.214722	2.2	2
1728.214722	3.8	3
1793.214722	7.7	7
1858.214722	9.3	3
1923.214722	15.3	11
1988.214722	23.5	15
2053.214844	39.3	29
2118.214844	51.4	22
2183.214844	61.7	19
2248.214844	68.9	13
2313.214844	75.4	12
2378.214844	82.5	13
2443.214844	86.9	8
2508.214844	92.3	10
2573.214844	97.8	10
2638.214844	100.0	4

=== PERSONAL PROSIM PLOT FACILITY === MODEL IS MPTSIM SELECTION IS F



↓:ZOOM ←:LEFT →:RIGHT Home:RESHOW End:QUIT

=== PERSONAL PROSIM HISTOGRAM FACILITY === MODEL IS MPTSIM SELECTION IS F

MEAN : 465.162659 MINIMUM: 210.166763
DEVIATION: 124.372406 MAXIMUM: 804.418213

UPPER BOUND	CUM PERC	183 ENTRIES
245.166763	1.6	3
280.166748	5.5	7
315.166748	9.3	7
350.166748	20.8	21
385.166748	28.4	14
420.166748	38.3	18
455.166748	48.6	19
490.166748	61.2	23
525.166748	70.5	17
560.166748	77.6	13
595.166748	83.1	10
630.166748	88.0	9
665.166748	92.9	9
700.166748	95.6	5
735.166748	97.8	4
770.166748	99.5	3
805.166748	100.0	1

Year			1990					1995					2005		
Crane		3		2	1		3		2	1		3		2	1
Alt.Working	II	III	IV	II	II	II	III	IV		III	II	III	IV		III
1. Berth Uti- lization (%)															
Samudra	2.50	1.93	1.37		2.62		2.06	1.52		2.19	4.96	4.13	2.95		4.12
Nusantara	11.87	8.78	6.61		12.13		11.29	8.85		11.22	38.32	26.40	19.14		26.26
Lokal	8.56	6.04	4.49		8.29		6.89	5.16		7.39	17.36	12.27	8.98		12.33
Khusus	5.76	4.33	3.21		5.91		5.46	4.01		5.49	15.82	11.24	8.33		11.24
Shuttle	1.56	1.25	1.24		1.70		1.76	1.69		1.58	3.90	2.96	2.91		2.94
R Barge	0.53	0.37	0.29		1.50		0.79	0.63		0.79	1.89	1.22	0.99		1.22
Total	30.78	22.70	17.21		31.14		38.26	21.86		28.92	82.26	58.21	43.30		58.10
2. Cost of Time in Port per Ship (US$)															
Samudra	6430	4805	3401		6571		4442	3195		4994	16548	5622	3706		5612
Nusantara	2698	1982	1473		2760		1956	1528		2007	6672	2162	1493		2155
Lokal	963	715	518		965		669	490		743	2406	764	533		770
Khusus	6371	4591	3383		6345		4892	3569		4751	15794	5996	4322		5995
Shuttle	10700	8211	8142		11102		7524	7236		8048	11045	7362	7090		7328
R Barge	69	51	40		66		52	42		52	389	58	42		58
3. Composition of Time in Port per ship (hrs)															
Samudra WT	0.00	0.00	0.00		0.00		0.01	0.00		0.02	69.61	1.86	0.34		1.86
U + MT	4.00	4.00	4.00		4.00		4.00	4.00		4.00	4.00	4.00	4.00		4.00
ULT	4.48	4.63	4.57		4.67		4.89	5.05		5.14	4.63	4.78	4.83		4.82
LT	5.67	5.83	5.70		5.86		4.73	4.91		4.95	5.03	5.22	5.23		5.23
IT	17.37	9.43	2.91		12.24		8.47	2.83		8.41	14.18	9.35	3.16		9.17
PT	31.52	23.90	17.18		31.76		22.10	16.78		22.52	97.45	25.21	17.56		25.08
Nusantara WT	0.03	0.00	0.00		0.06		0.01	0.00		0.03	57.30	1.29	0.11		1.30
U + MT	4.00	4.00	4.00		4.00		4.00	4.00		4.00	4.00	4.00	4.00		4.00
ULT	9.68	9.90	9.87		9.86		9.94	10.18		10.36	10.86	10.81	10.61		10.78
LT	1.31	1.32	1.32		1.32		1.25	1.27		1.27	1.08	1.07	1.06		1.07
IT	17.37	8.69	3.08		17.56		8.68	3.25		8.85	20.64	9.71	3.31		9.72
PT	32.39	23.92	18.27		32.80		23.89	18.70		24.50	93.88	26.88	19.10		26.87

Lokal	WT	0.02	0.00	0.00	0.01	0.00	0.00	0.00	62.34	1.44	0.04	1.44
	U + MT	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
	ULT	10.04	10.34	10.26	10.31	9.50	9.31	10.40	10.31	10.19	10.09	10.19
	LT	2.56	2.62	2.61	2.61	2.62	2.57	2.83	3.10	3.09	3.06	3.09
	IT	20.42	10.44	3.68	20.89	9.30	3.32	10.43	22.03	10.97	3.67	11.08
	PT	37.04	27.39	20.55	37.82	25.42	19.19	27.65	101.79	29.68	20.85	29.79
Khusus	WT	0.01	0.00	0.00	0.01	0.00	0.00	0.00	66.42	1.10	0.14	1.10
	U + MT	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
	ULT	12.77	12.89	13.00	12.69	13.90	13.72	13.71	16.27	16.04	16.26	16.02
	LT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	IT	20.42	10.45	3.57	20.09	11.14	3.88	10.73	25.41	13.20	4.63	13.20
	PT	37.20	27.35	20.57	36.80	29.04	21.59	28.44	112.10	34.34	25.02	34.32
Shuttle	WT	0.00	0.00	0.00	0.00	0.03	0.00	0.06	5.91	0.76	0.14	0.76
	U + MT	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
	ULT	15.45	16.29	16.16	16.08	11.76	11.28	12.54	10.88	10.91	10.76	10.88
	LT	9.67	10.14	10.06	10.06	12.17	11.67	13.05	11.76	11.79	11.52	11.73
	IT	16.63	0.00	0.00	11.06	0.00	0.00	0.00	8.58	0.00	0.00	0.00
	PT	39.75	30.43	30.22	41.20	27.96	26.95	29.66	41.12	27.45	26.41	27.36
R Barge	WT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	62.00	1.45	0.04	1.45
	U + MT	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
	ULT	3.01	3.01	3.01	3.01	3.02	3.02	3.01	3.03	3.03	3.03	3.03
	LT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	IT	6.69	3.24	0.90	6.69	3.49	1.30	3.47	8.68	3.12	1.26	3.12
	PT	13.70	10.25	7.91	13.70	10.51	8.31	10.48	77.72	11.60	8.35	11.60

4. Number of ships which berth not at preferred quay

a) Ships Carrying International Cargo at Domestic Quay									
Samudra	2	of	57	2	of	66	18	of	120
Khusus	0	of	36	0	of	51	6	of	106
Shuttle	0	of	24	0	of	37	0	of	64
R Barge	1	of	70	1	of	146	28	of	230
b) Ships Carrying Domestic Cargo at International Quay									
Nusantara	25	of	416	31	of	522	234	of	1180
Lokal	24	of	398	11	of	479	118	of	788
Khusus Dom.	6	of	78	5	of	83	22	of	125

5. Number of ships which stop cargo handling one time due to arrival of shuttle
(no ship stops cargo handling for twice or more)

Samudra	0	1	0
Nusantara	0	0	4
Lokal	0	0	8
Khusus	0	0	6
R Barge	0	0	4
		Ø	

6. Quantity of Cargo in storage (1000 tons)	Ave-rage	Maxi-mum	A	M	A	M
a. NCC-Int						
In shed	0.96	1.68	1.18	1.86	1.96	3.06
In yard	1.48	5.16* (3.20)	2.14	4.64	4.32	8.61
b. NCC-Dom						
In shed	1.05	1.92	1.21	2.19	2.12	3.00
In yard	0.84	1.46	1.01	1.64	2.03	2.67
c1. Container (I)						
'In shed'	-	-	-	-	-	-
In yard	0.80	1.91	1.32	2.55	2.52	3.88
c2. Container (II)						
'In shed'	-	-	0.45	0.83	2.09	3.18
In yard	-	-	0.87	1.72	0.43	0.70
c3. Container (III)						
'In shed'	-	-				
In yard	-	-				

7. Routing of Cargo (1000 tons)	1990 via shed	1990 via yard	1995 via shed	1995 via yard	2005 via yard	2005 via yard
a. NCC-Int,						
Outbound	7.13	5.92	9.44	7.82	10.24	8.64
Inbound	17.44	29.47	23.46	43.45	36.43	87.96
Subtotal	24.57	35.39	32.90	51.27	46.67	96.60
b. NCC-Dom,						
Outbound	0.38	1.14	0.49	1.40	0.88	2.53
Inbound	23.21	21.56	28.00	27.07	49.09	55.03
Subtotal	23.59	22.70	28.49	28.47	49.97	57.55
c. Container,						
Outbound	0	9.62	7.44	22.34	57.33	12.74
(II) Inbound	0	21.59	11.26	20.64	52.94	8.82
Subtotal	0	31.21	18.70	42.98	110.27	21.56

Note:
WT = Waiting Time
U+MT = Unmooring + Mooring Time
ULT = Unloading Time
LT = Loading Time
IT = Idle Time
PT = Port Time