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Analysis and evaluation of the impact of privatisation on the performance of container handling equipment in Jakarta International Container Terminal (JICT), Indonesia

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ANALYSIS AND EVALUATION OF THE IMPACT OF PRIVATISATION ON THE PERFORMANCE OF CONTAINER HANDLING EQUIPMENT IN JAKARTA INTERNATIONAL CONTAINER TERMINAL (JICT), INDONESIA

By

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The Republic of Indonesia

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DEDICATION

I dedicate this paper to:

- *my mother, to whom I always berth my boat of life*
- *my father, who has built the strong boat of life in my heart*
- *my wife, who always accompanies me in the sailing of life*
- *my son, to whom I am preparing the strong boat of life in his heart*

"So verily, with the hardship, there is relief,"

(Surat Alam Nashrah: 5)

DECLARATION

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

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

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ABSTRACT

Title : Analysis and Evaluation of the Impact of Privatisation on the Performance of Container Handling Equipment in Jakarta International Container Terminal (JICT), Indonesia.

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Equipment maintenance in an organisation is often deemed as a cost centre. In order to achieve a maximum profit an organisation often pressures the cost. In this case, equipment maintenance is often to be an object in decreasing that cost. On the other hand, the lack of maintenance may lead equipment to perform poorly. In addition, these poor performances may lead the organisation to perform poorly as well.

In a container terminal organisation, equipment maintenance plays an important role for the terminal performance. A good practice of maintenance policy and strategy leads the terminal to perform well and vice versa. As a State-owned company, *Unit Terminal Petikemas* (UTPK) Tanjung Priok, Jakarta, often faced barriers which came from government regulations in practising those maintenance policies and strategies. That barrier does not exist anymore after the terminal was privatised and given the name Jakarta International Container Terminal (JICT).

This dissertation studies and analyses the impact of privatisation on the performance indicators of equipment maintenance, namely equipment availability, utilisation, MTBF, MMBF and MTTR. It is also proposed to practise some action in order to improve the performances by practising predictive maintenance as well as preventive maintenance and corrective maintenance, and by restructuring the organisation structure in order to raise the quality of the professional engineers and maintenance staff.

KEYWORDS: Privatisation, JICT, Availability, MTBF, MMBF, MTTR, Predictive Maintenance, Preventive Maintenance, Corrective Maintenance.

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LIST OF ABBREVIATIONS

Ae	Availability equipment
Ai	Availability inherent
Ao	Availability occupied
Bappenas	Badan Perencanaan Pembangunan Nasional (National Development Planning Agency)
BOT	Build Operate and Transfer
CAMC	Computer Assisted Maintenance Control
CC	Container Crane
CHS	Chassis
CM	Corrective Maintenance
EMIS	Engineering Management Information System
FD	Forklift Diesel
HPH	Hutchison Port Holding
HRPD	Human Resources Planning and Development
HT	Head Truck
IPC II, Ltd.	Indonesia Port Corporation II, Limited
ISO	International Organisation for Standardisation
JICT	Jakarta International Container Terminal
Keppres	Keputusan Presiden (Presidential Decree)
M&R	Maintenance and Repair
MHC	Mobile Harbour Crane
MIS	Management Information System
MMBF	Mean Movement Between Failure
MTBF	Mean Time Between Failure
MTTR	Mean Time To Repair
PdM	Predictive Maintenance
PM	Preventive Maintenance
RTGC	Rubber Tyre Gantry Crane

TEUs	Twenty Foot Equivalent Units
UNCTAD	United Nations Conference on Trade and Development
UTPK	Unit Terminal Petikemas Tanjung Priok (Tanjung Priok Container Terminal Unit)

INTRODUCTION

The Jakarta International Container Terminal (JICT), formerly the *Unit Terminal Petikemas Tanjung Priok* (UTPK) or Tanjung Priok Container Terminal Unit, is the largest container terminal in Indonesia presently. The terminal is mainly serving Indonesian sea-borne trade. As the largest container terminal and the server of Indonesian sea-borne trade, JICT has a big contribution in the developing of Indonesian exports and imports trading; furthermore in the growth of the Indonesian national economy. This has been proven by the increase in the terminal throughput since operations began in 1978 up to 1996. In the middle of 1997, Indonesia suffered an economic crisis, which had a great impact on the performance of the terminal up to 1999. In April 1999, the terminal was privatised by selling 51% of the shares to a private company. **What are the impacts of this privatisation on the performance of container handling equipment?** This is the essential question to be discussed in this dissertation.

A. Port Privatisation

The technologies of containerisation, either the container itself or container vessel, are developing so quickly. Shipping companies provide services to meet and satisfy either shippers or cargo-owners for transporting cargo. There is no doubt that sea transportation is the cheapest transportation mode among other modes. In order to achieve the economies of scale, some high-value cargoes now are transported by container vessels. Therefore, the time in port has become an essential factor for shipowners, shippers and cargo-owners.

The port as a service-supplier institution is required to perform as well as the customers' requirements. Shipping companies as port users have a right to select which port they want to call at. The better the ports can perform, the more they can likely attract shipping companies. This situation creates competition among the ports to attract customers.

Since time in ports as an element of competition becomes more significant for port users, the port operators have been required to improve their performances. In most developing countries, ports are owned and operated by the state or government. Here regulations and public control limit performance and consequently efficiency is not as good as in the private sector (Kolderie, 1986). Investment and competition ability are often the main difficulties that state or government in developing countries face in improving port performances. In order to overcome these problems, privatisation becomes an alternative way. This is what happened in JICT in order to strengthen the capital structure.

B. The Importance of Equipment Maintenance

Historically, maintenance probably started out as a need to fix a machine when it was breaking down during operations. As the first person who faced the failure, the machine operator performed the repair on the machine (UNCTAD, 1983). Together with the development of technology, equipment becomes much more complex, leading to special skills, tools, equipment and material for the repairs. These typical requirements are almost impossible to be discovered by the operators themselves. Therefore, to deal with modern and more complex equipment, well-trained maintenance staff are needed as well as operator staff.

Such symptoms also happen in the ports. The development of containerisation has led the ports to change the operational pattern from traditional to fully automatic. This situation requires ports to provide facilities in order to perform cargo handling well; therefore, equipment maintenance becomes an essential factor.

C. The Objective

The objective of this study is to understand the impact of privatisation on the performance of container handling equipment, especially in JICT. It also attempts to find out and explain the problems which are often faced by management related to the management of equipment maintenance.

D. Methodologies

In order to know those impacts of port privatisation on the performance of container handling equipment, a comparative method is used, that is the comparison of equipment before and after privatisation. Basically, the equipment to be compared is physically the same. The differences are only the organisation which manages that equipment and the time frame in which the equipment performs.

From the organisation point of view, comparison is done between UTPK and JICT. UTPK is one of the operation units of Indonesia Port Corporation II, Ltd. (IPC II), which is a fully State-owned company. Several months before privatisation, UTPK was changed from an operation unit to a subsidiary company, namely Jakarta International Container Terminal (JICT). The new management, which consists of IPC II and Hutchison Port Holding as another share holder, has kept the name JICT.

From the time-frame point of view, JICT was established when Indonesia was facing an economic crisis, which began in the middle of 1997 and has not finished yet. Therefore, it is necessary to consider taking two periods of time which are relatively similar. This means that by taking two one-year periods of 1998 (before privatisation) and 1999 (after privatisation) the analysis would represent periods which are as close to the same situation as possible.

Comparison is done by measuring the availability, utilisation, break down time and other equipment performance parameters which might be affected by the performances of the two different organisations. In order to get accurate data, interviewing and investigation of the management of JICT is done. Correspondence to the management of JICT is also the important method in order to clarify the arguments with the realities in the field. Furthermore, comparison is done by taking the author's knowledge, experiences and information during field trips to other ports, in order to find out the ideal model which might be applied to JICT.

CHAPTER I
JAKARTA INTERNATIONAL CONTAINER TERMINAL AT A GLANCE

1.1 History of JICT

The history of JICT can not be separated from the history of containerised-goods transportation in Indonesia, which was first introduced in 1973. Then there was a small number of containers being unloaded in the Port of Tanjung Priok by conventional equipment (Indonesia Port Corporation [IPC] II, 1996). Since then the growth of container traffic has increased steadily from year to year.

In October 1974, a new container terminal was built in the Port of Tanjung Priok in order to anticipate growth in both container vessel and container traffic. In December 1978, the terminal started to operate services although the process of building the terminal had not finished. In May 1981 the terminal was inaugurated by the President of the Republic of Indonesia.

In 1990, the second terminal was built by modifying the existing conventional berths to anticipate the growth of container traffic. The terminal was inaugurated in September 1991 and within the same year the container terminal was managed by a separate unit which was as level as the Port of Tanjung Priok Branch, namely *Unit Terminal Petikemas Tanjung Priok* (UTPK) or Tanjung Priok Container Terminal Unit. Since then UTPK has grown together with the growth of the Indonesian economy.

In the middle of 1997, Indonesia suffered a monetary and economic crisis. The crisis led government, which is the single shareholder of State-owned companies, decided to privatise some of the companies including the Indonesia Port Corporation II, Ltd., in order to strengthen its capital structure ("Suara Pembaruan Daily," 1998). In order to execute the privatisation, Indonesia Port Corporation II, Ltd. established UTPK as a subsidiary firm of Indonesia Port Corporation II in March 2000, namely Jakarta International Container Terminal (JICT). On 1st April 1999, JICT was privatised by selling 51% of the shares to Hutchison Port Holding (HPH), Hongkong. The remaining 49% of the shares were owned by Indonesia Port Corporation II, Ltd. The joint venture company of JICT would operate and develop container terminals I and II for a period of 20 years under a Build Operate and Transfer (BOT) concession (Agustomo, 1999). This means that after JICT has built and operated the terminal for 20 years, JICT has to transfer the terminal to the previous owner, i.e., Indonesia Port Corporation II, Ltd.

1.2 Container Throughput

Since the terminal was established in 1978 the throughput has increased tremendously from year to year. The last nine years of throughput, that is since the second terminal officially came into operation, can be seen in the following table.

Table 1.1 Container throughput 1991 - 1999

YEAR	SHIP CALLS	GRAND TOTAL		
		BOX	TEUS	TON
1991	1,355	455,714	621,568	5,809,838
1992	1,838	601,318	815,651	7,861,141
1993	2,005	707,801	978,305	8,960,324
1994	1,984	829,281	1,164,132	10,428,854
1995	1,492	916,870	1,300,126	12,185,029
1996	1,574	985,918	1,421,693	13,414,424
1997	1,665	1,047,977	1,533,104	13,290,016
1998	1,580	968,056	1,424,961	10,585,603
1999	1,588	993,685	1,472,504	12,630,159

Source: JICT, Electronic Data Processing and Marketing, 1999.

The performance of individual terminals in the years of 1998 and 1999 can be seen in the following tables:

Table 1.2 Container handling throughput 1998

Month	Terminal I		Terminal II		Total	
	Boxes	TEUS	Boxes	TEUS	Boxes	TEUS
January	52,764	78,651	15,493	22,200	68,257	100,851
February	43,446	64,526	14,931	21,641	58,377	86,167
March	65,235	95,988	20,863	29,583	86,098	125,571
April	61,823	92,010	23,549	33,054	85,372	125,064
May	56,578	84,327	18,468	26,708	75,046	111,035
June	69,714	104,797	20,163	29,022	89,877	133,819
July	69,831	103,859	17,871	25,768	87,702	129,627
August	68,989	101,873	18,832	27,641	87,821	129,514
September	67,424	99,111	14,800	21,885	82,224	120,996
October	69,021	100,836	15,175	21,791	84,196	122,627
November	62,942	92,745	17,020	24,744	79,962	117,489
December	68,186	100,561	14,925	21,626	83,111	122,187
Total	**755,953**	**1,119,284**	**212,090**	**305,663**	**968,043**	**1,424,947**

Table 1.3 Container handling throughput 1999

Month	Terminal I		Terminal II		Total	
	Boxes	TEUS	Boxes	TEUS	Boxes	TEUS
January	55,863	83,244	11,753	17,239	67,616	100,483
February	56,161	83,695	12,611	18,047	68,772	101,742
March	67,788	100,002	16,541	24,056	84,329	124,058
April	70,660	106,009	14,258	21,113	84,918	127,122
May	75,065	112,845	16,781	24,721	91,846	137,566
June	68,666	103,615	14,257	21,208	82,923	124,823
July	69,977	103,216	14,511	20,998	84,488	124,214
August	67,356	98,507	15,235	21,557	82,591	120,064
September	64,014	95,390	16,256	22,572	80,270	117,962
October	69,970	104,455	15,680	21,680	85,650	126,135
November	74,056	112,663	16,449	22,610	90,505	135,273
December	72,194	108,678	17,583	24,384	89,777	133,062
Total	**811,770**	**1,212,319**	**181,915**	**260,185**	**993,685**	**1,472,504**

From the tables above, it can be seen that the total throughput of container handling increased by 3%. However, in terminal II, the annual throughput of 1999 decreased by 15%. One of the reasons was that the number of gantry cranes in terminal II was reduced by one unit.

1.3 Structure of Organisation

As mentioned above, before it was privatised UTPK or Tanjung Priok Container Terminal Unit, the former organisation of JICT, was one of the branches and units under the Indonesia Port Corporation II, Ltd. (IPC II). The head of UTPK was responsible to the Director of IPC II. The structure of the organisation related to the equipment maintenance was:

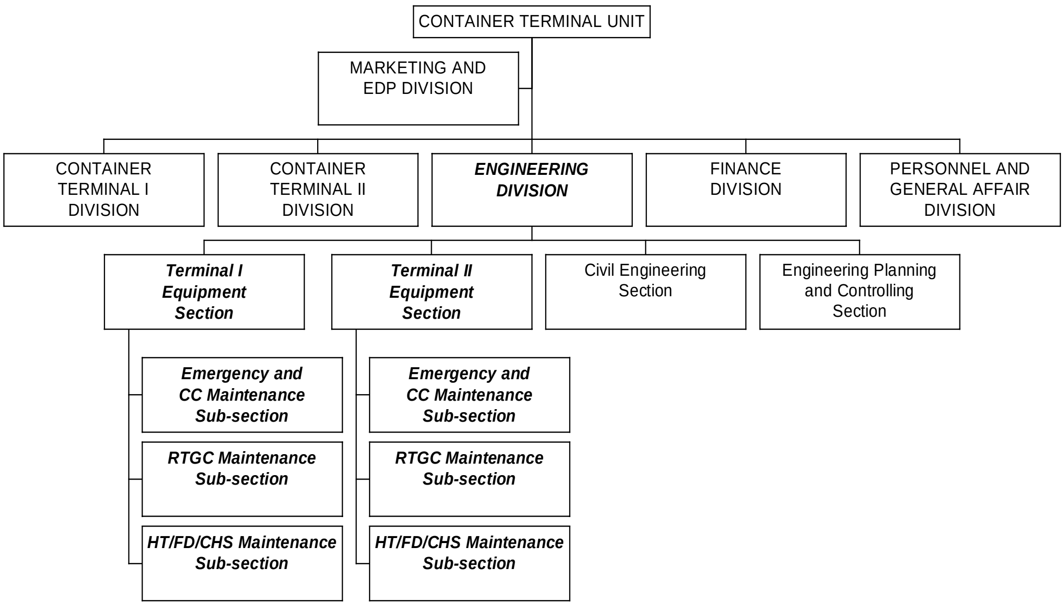


Fig. 1.1 Organisational structure of Equipment Maintenance Department of UTPK

Note:
- CC : container crane
- RTGC : rubber-tyre gantry crane
- HT : head truck
- FD : diesel forklift
- CHS : chassis (trailer)

In this organisation structure, Terminal I and Terminal II Divisions were operational departments which were responsible for all the equipment operators. This division of the organisation seemed less effective from the co-ordination point of view as the operators were the first people who faced equipment trouble. In case there was trouble, operators should inform the maintenance staff as soon as possible so that the idle time could be shortened.

Since Hutchison Port Holding (HPH) took over the majority of the shares, the structure of organisation has been changed in order to improve performance. This change of the organisational structure also happened in the equipment maintenance department. The structure which has been set up is:

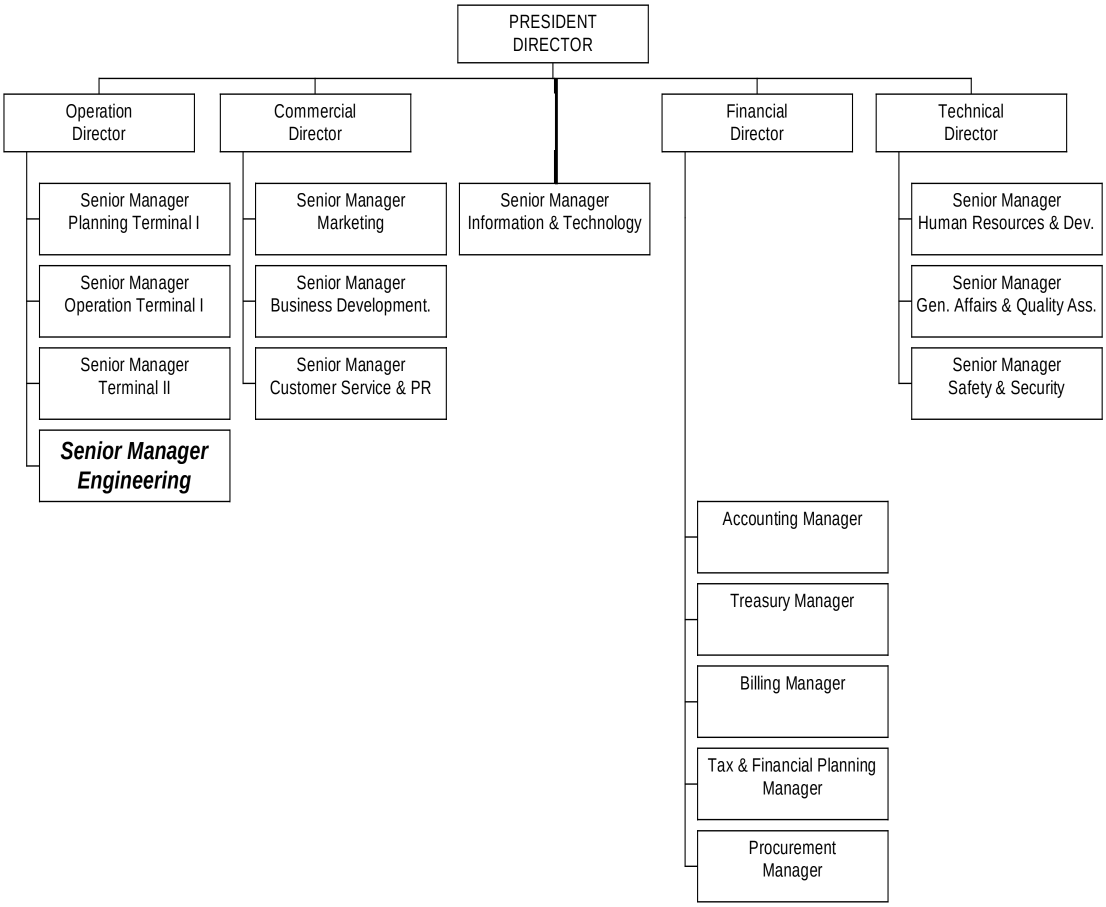


Fig. 1.2 Organisational structure of JICT

Organisational structure related to Equipment Maintenance

As shown above, the engineering department is the sub-ordinate of the Operation Director. This organisation structure is set up in order to shorten and simplify the co-ordination of the operation department and equipment maintenance department; therefore, a harmonised communication between both departments could be created (UNCTAD, 1986). The entire organisational structure under the Operational Directorate and the organisational structure related to equipment maintenance management are:

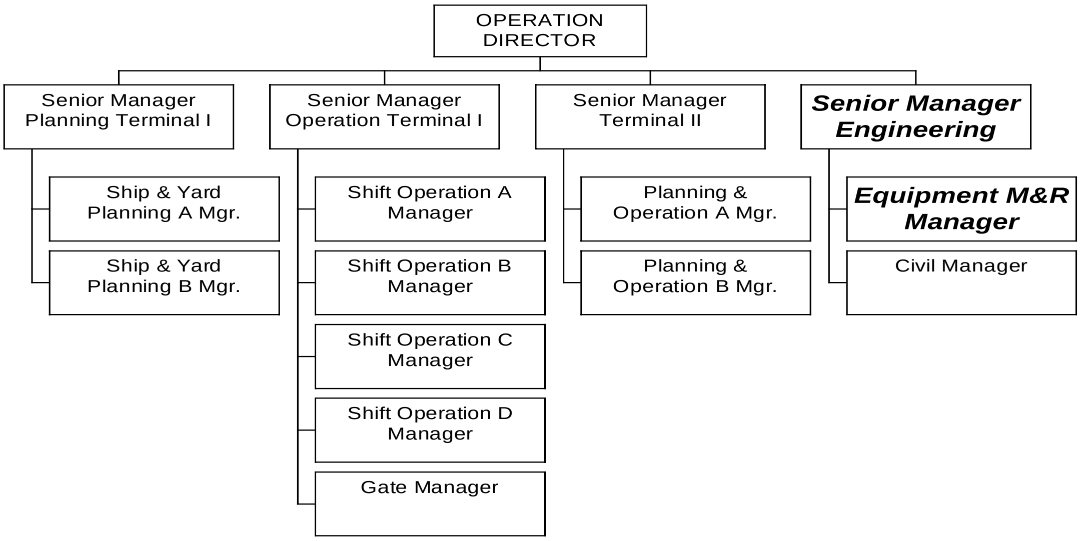


Fig. 1.3. Organisational structure of Operation Directorate of JICT

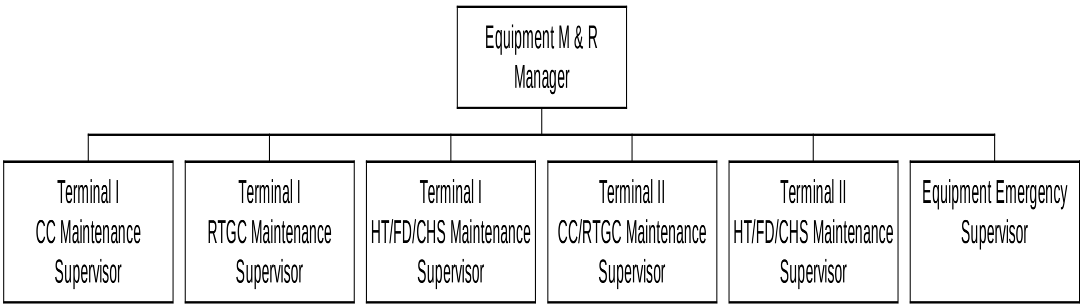


Fig. 1.4. Organisational structure of Equipment Maintenance and Repair

The change which occurs at the level of supervisors is that the supervisors of maintenance of CC and RTGC in the terminal II are under the responsibility of one person, due to the reduction in the number of owned-CC from two units to one unit only. By involving CC and RTGC in one supervisor level, the JICT's management hopes that the efficiency of employment can be improved. Another change is that equipment emergency staff has become one level of supervision. The purpose of setting up this supervisor is to simplify co-ordination among staff. In the previous organisation, the equipment emergency staff belonged to each supervisor (maintenance of CC, RTGC and HT/FD/CHS).

1.4 Vision and Mission of JICT

Having been established as a subsidiary company of Indonesia Port Corporation II, JICT is ready to be the best container terminal in Indonesia and at a world class level of container terminals, by employing modern equipment and facilities (JICT, 1999). In order to achieve these objectives, JICT has set up its vision, mission and company commitment.

The company's vision is to service its customers or port users by consistent professional-service in order to meet the customer requirements. The company's mission is to develop a port system and technology to support the role of port as the national economic gateway.

The company's commitments are:

- to continuously improve the quality of services,
- to maintain the synergy between the company and its environment by involving and maintaining the right man in the port business, and
- to continuously improve and develop company's skill and ability as the guarantee in maintaining the leadership in the port sector.
  (JICT, 1999).

The company management recognises that in order to realise its vision and mission the company should understand and balance the needs of customers, employees, shareholders and company environments. JICT in the Quality Manual of ISO 9002 document, 1999, states:

> Commitment to the customers is to meet the requirements that have been agreed. Commitment to the employees is to guarantee the work condition and environment that leads to be conducive and providing the occasion for the employees to develop all of their potency. Commitment to the share holders is to highly honour the ethic and principle of law in doing business planning by professional way. Commitment to environments is to create job opportunities to involve in the port business.

1.5 Summary

1. In 1999, when Indonesia suffered an economic crisis, UTPK was privatised in order to strengthen its capital structure. The terminal henceforth was named Jakarta International Container Terminal (JICT), and operated by a joint venture company between Indonesia Port Corporation II, Ltd. and Hutchison Port Holding (HPH), Hongkong.
2. HPH as the majority shareholder of JICT in operating the terminal changes the structure of organisation in order to improve the efficiency and performance of the company. Change also occurred in the amount of container handling equipment, which has led to affect annual throughput.

CHAPTER II
CONTAINER HANDLING EQUIPMENT

2.1 Existing Container Handling Equipment

In order to realise the achievement of the vision and mission, JICT continuously serves its customer by increasing the quality of service as close to the customer requirement as possible. The quick, right, safe and convenient service at a level as a world class container terminal always becomes a priority. This condition leads JICT to have a commitment to meet and exceed the customer requirements by being professional, innovative and continuously improving service. One of the actions which has been taken by JICT is to provide adequate equipment in order to quickly serve loading, unloading, receipt or delivery operations.

One of disadvantages which is presently faced by JICT is the limitation of land resources to develop either the berths or container yards. Presently, JICT has two terminals. Terminal I is composed of a 900 meter-length quay with 31.4 Ha container yard and –12 meter-depth. Terminal II has a 510 meter-length quay with 6.83 Ha container yard and –9 meter-depth (Jakarta International Container Terminal, 1999). Presently, JICT is also preparing a 262 meter-length new quay in the terminal I with –14 meter-depth. This new quay is prepared to anticipate post panamax container vessels which are expected to call at JICT. On the other hand, the supply of human resources which is relatively plentiful and cheap is one of the advantages of JICT.

By taking into consideration those advantages and disadvantages, JICT employs a rubber-tyre gantry crane (RTGC) system for the operation system. This system needs trailers to support the operation by transporting containers from the quay to the yard. For imports or discharging operations, containers are discharged from the ship by container crane (CC) and picked up and transported to the yard by trailer. The trailer is composed of head truck (HT) and chassis. In the stacking yard, the containers are picked up by RTGC and stacked to the slot which is planned before. The system is also applied to the exports or loading operation. In a particular case, the handling of containers is done by top loader or side loader. Top loader and side loader are a kind of forklift which is completed by a specific attachment to handle the container, namely a spreader. This kind of operation is normally applied to the receiving of export empty containers from the external trailer.

As mentioned above, terminal I is composed of a 1162 metre-lengths quay. 262 meters of it is a new construction and has not been equipped yet. The remaining 900 meter-length quay is served by 8 CC and 3 mobile harbour cranes (MHC). The following table is the comparison data of equipment before and after privatisation:

Table 2.1 Comparison of the existing container handling equipment before and after privatisation

Equipment	Before privatisation (1998)					After privatisation (1999)				
	Terminal I		Terminal II		Total	Terminal I		Terminal II		Total
	Owned	Leased	Owned	Leased		Owned	Leased	Owned	Leased	
CC	8	-	2	3	**13**	8	-	1	3	**12**
MHC	-	3	-	-	**3**	-	3	-	1	**4**
RTGC	22	9	10	3	**44**	21	9	11	3	**44**
HT	59	-	15	-	**74**	56	-	15	-	**71**
FD	13	-	7	-	**20**	10	-	7	-	**17**
CHS	64	-	28	-	**92**	63	-	29	-	**92**

Source: JICT, Engineering Department, 1999c.

Note:
- CC : shore container crane
- MHC : shore mobile harbour crane
- RTGC : yard rubber tyre gantry crane
- HT : yard tractor
- FD : diesel forklift
- CHS : chassis

All CCs are panamax type with diesel engine as the main power in terminal I and electrical power supply in terminal II. All RTGC's capacity are one over four high container stack, except 7 units owned-RTGC in terminal II which are one over three high container stack. The loading capacities of CC, RTGC and HT are 40 tons. The forklift (FD) consists of:

Table 2.2 Comparison of capacity and number of forklifts before and after privatisation

Capacity	Before privatisation (1998)			After privatisation (1999)		
	Terminal I	Terminal II	Total	Terminal I	Terminal II	Total
2 tons	4	3	**7**	4	3	**7**
3.5 tons	1	-	**1**	1	-	**1**
10 tons	-	1	**1**	-	1	**1**
15 tons	4	1	**5**	2	1	**3**
25 tons	2	-	**2**	1	-	**1**
36 tons	1	1	**2**	1	1	**2**
42 tons	1	1	**2**	1	1	**2**
Total			**20**	**Total**		**17**

The function of forklifts is mainly to support the operation and maintenance activities. They are not classified as the main container handling equipment. For the main handling operation system, JICT only employs CC, RTGC and trailer, which is composed of HT and chassis. Due to such a function of the forklifts, the analysis of forklift performance will be less than other kinds of equipment.

In terms of leased equipment, all maintenance matters are under the responsibility of the owner or lessor. Due to the condition, an analysis of this leased equipment is excluded.

2.2 Performance of Equipment before Privatisation

The management of UTPK measured the performance of equipment by taking into account the achievement of equipment availability, utilisation and break down. The management of UTPK defined those of the performance indicators as follows:

a). Availability was defined as the comparison between the total number of time available for equipment to be utilised and the total number of working hours in a specific time period (monthly).

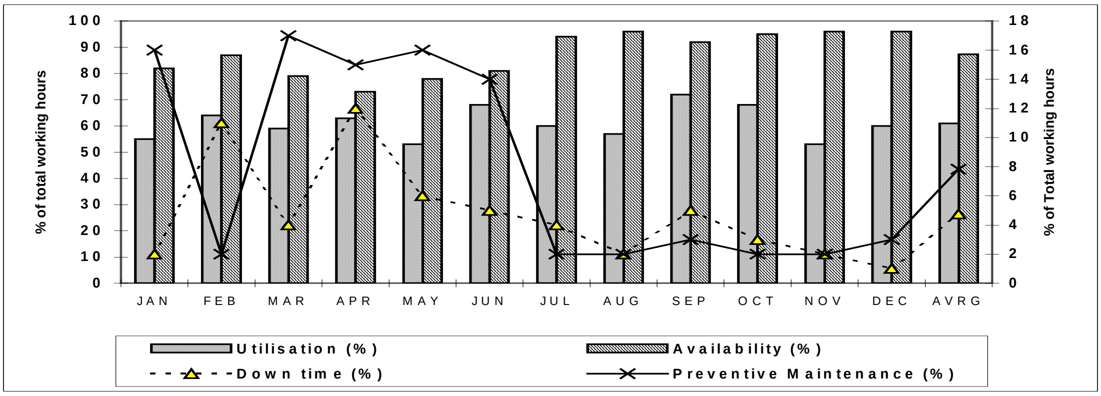
b). Utilisation was defined as the comparison between the total number of time that equipment has been utilised and the total number of working hours in a specific time period (monthly).

c). Break-down was defined as the comparison between the total number of time that equipment has broken down or been failure and the total number of working hours in a specific time period.

Available time was defined as total working hours minus total break down time and total maintenance time. Working hours is defined as total time when terminals open to operate. By taking into account those performances in the evaluation, the management expected that the achievement of either equipment operation or personnel of the maintenance staff could be measured.

It has been mentioned in the previous chapter that the privatisation was done when Indonesia was facing an economic crisis, and economically, the impact of the crisis had not finished up to the beginning of 2000. Referring to such a condition, data of performances was taken from the same situation, that is during the economic crisis. Data of performance before privatisation was taken during the year of 1998 and can be seen in its entirely in the following graphs:

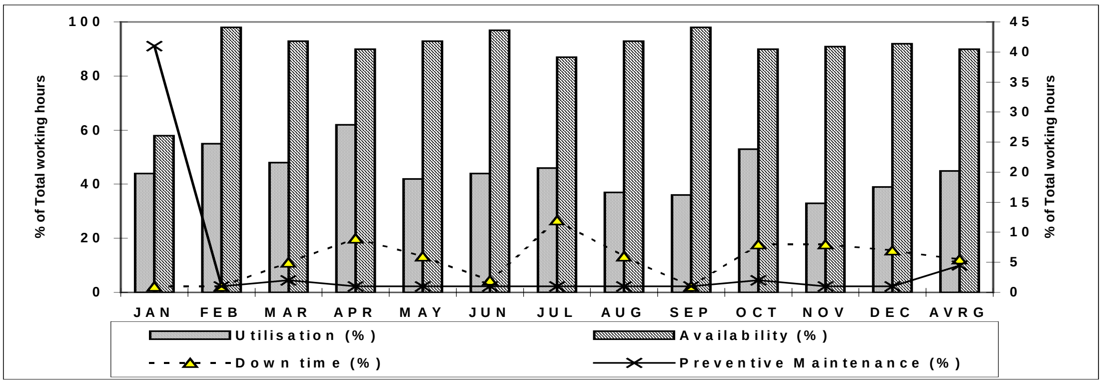
Fig. 2.1 The graph of performance of container cranes in terminal I, 1998



Source: Unit Terminal Petikemas Tanjung Priok, Report of Equipment Performances, 1998

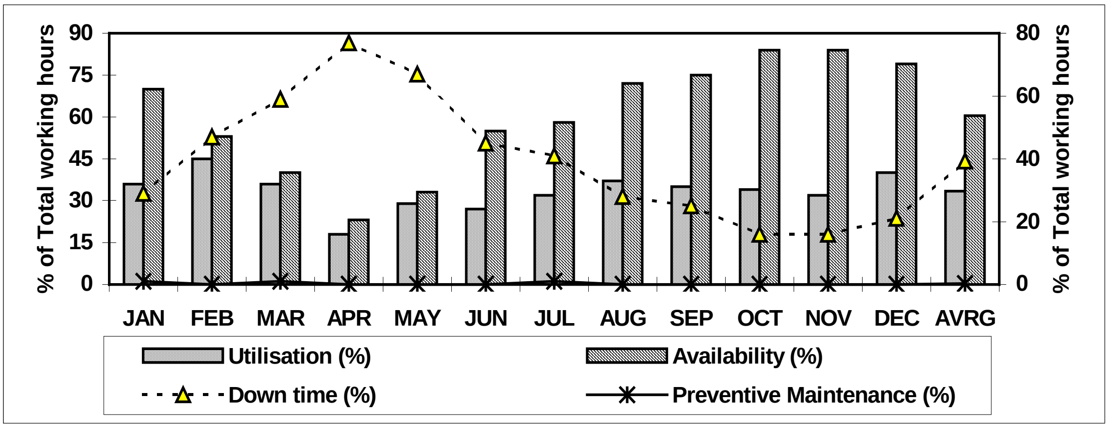
By the average availability of 87%, CCs' performance was less standard compared to the standard availability of 95% in Europe (Crook & Ircha, 2000b, Lecture Note). Preventive Maintenance in the periods of March to June was quite high, on average 15%. This was mainly caused by the low traffic at the moment, so that there was enough time available to maintain that equipment.

Fig. 2.2 The graph of performance of rubber-tyre gantry cranes in terminal I, 1998



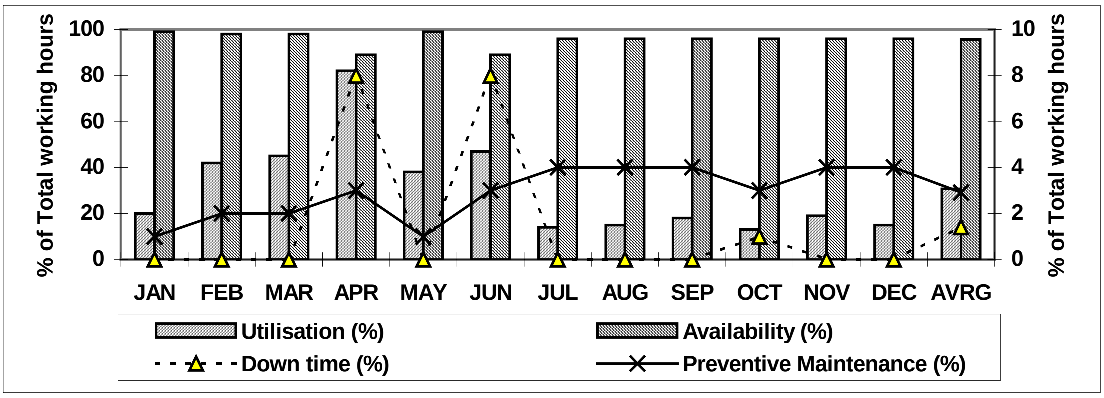
In January 1998 there were three units of RTGC under retrofit process, so that the figure of preventive maintenance in this month was very high (41%). Retrofit is defined as the maintenance activity by checking, readjusting, reconditioning and replacing the whole system of the machine in order to improve the reliability of the machine as close to the new condition as possible.

Fig. 2.3 The graph of performance of head trucks in terminal I, 1998



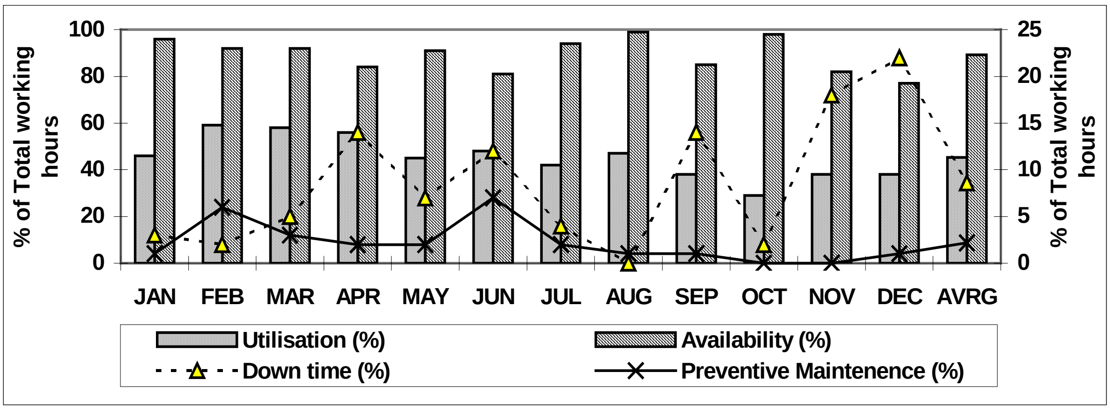
The main problem that led to the down time being very high in the periods of the first six months was the lack of rubber wheel-tyre available at the moment. The impact of the economic crisis affected the increase in the parts' price. Another reason was that the long procedure should be done in obtaining spare parts. This was why the availability of that equipment was very low, on average 60%.

Fig. 2.4 The graph of performance of container cranes in terminal II, 1998



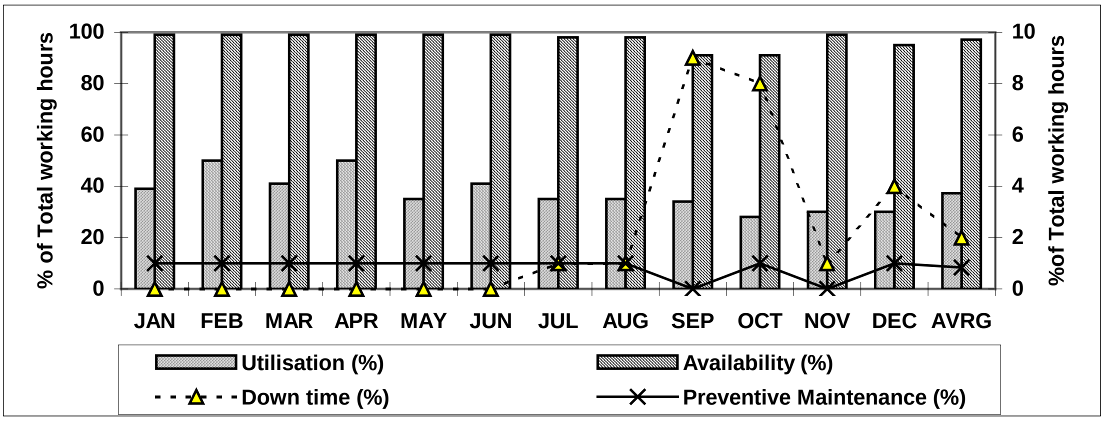
The availability of those CCs was very high, but the utilisation was very low. This condition was mainly caused by over supply of CC in the terminal II at the moment (five units), whereas the length of the quay was 510 meters with –9 meters depth, which is limited to the size of ship to berth.

Fig. 2.5 The graph of performance of rubber-tyre gantry cranes in terminal II, 1998



The average availability of RTGCs of 89% and utilisation of 45% was quite good. The down time of 18% in November and 22% in December was caused by problems in electrical control system parts which should be imported from the country of origin. The long time for their procurement was caused by the increase in price as an impact of the economic crisis and the procedure that should be done at the moment.

Fig. 2.6 The graph of performance of head trucks in terminal II, 1998



The performances of HTs were relatively the same as RTGCs. The availability was very high, on average 97%, but the utilisation was quite low, on average 37%.

By looking at the graphs above, it can be seen that the availability of equipment in terminal II was better than in terminal I, but the utilisation of equipment in terminal I was higher than in terminal II. This condition was reasonable due to container traffic in both terminals (table 1.2 chapter I).

2.3 Performance of Equipment after Privatisation

Soon after privatisation was complete, the new management modified some policies and strategies in order to improve the performance of the company. The change of the policy was not only the change of organisational structure, but also the policy of the operation system including equipment maintenance.

2.3.1 Changing in measuring methods

One of the changes which has happened in the equipment maintenance management is that the parameters of the evaluation has been changed in order to reflect the achievement of economic activity. The management of JICT tends to measure the performance of equipment related to the operation. Due to this objective, JICT management measures mean movement between failures (MMBF) and mean time to repair (MTTR).

MMBF is defined as the number of containers that can be moved or handled in between two failures or break-downs. MMBF is concerned more with production rather than time scale. The production is expressed by the number of containers which can be moved by that equipment. MTTR is defined as the average time needed by maintenance staff to deal with each failure or break down. With such kinds of parameters JICT's management expects that the productivity of equipment can be measured as close to the real condition as possible.

There are also some changes in terminology of equipment performance indicators. JICT divides availability into three different terms, namely availability equipment, availability inherent and availability occupied.

a). Availability equipment is defined as:

$$\mathrm{Ae} = \frac{\text{Number of equipment available to operate}}{\text{Total number of equipment}}$$

b). Availability inherent is defined as:

$$\mathrm{Ai} = 1 - \frac{\text{Break down time} + \text{Preventive Maintenance}}{\text{Total possible time in present month}}$$

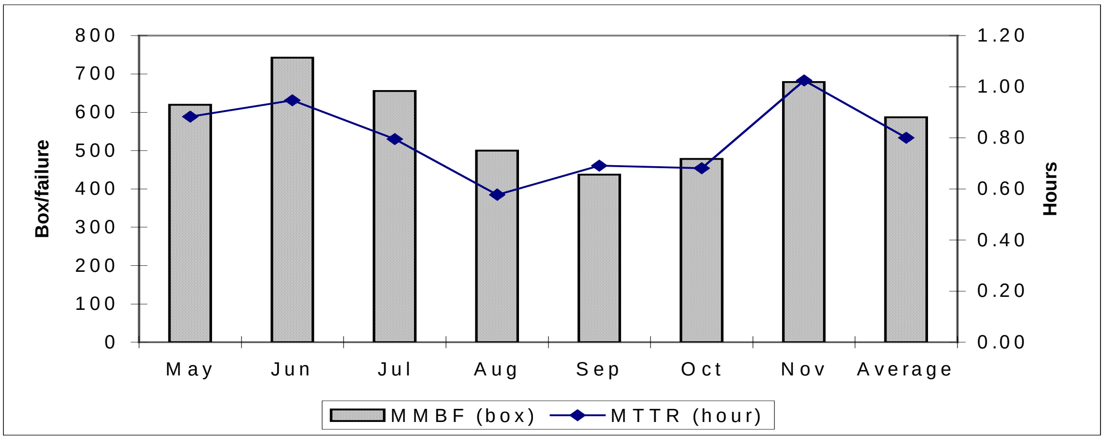
c). Availability occupied is defined as:

$$\mathrm{Ao} = 1 - \frac{\text{Break down time}}{\text{Engine hour meter}}$$

2.3.2 Equipment performances

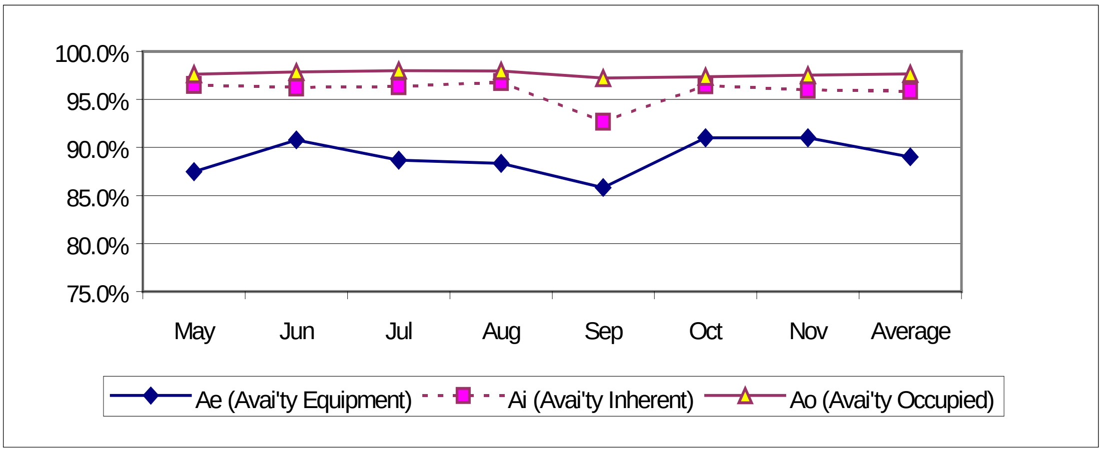
In order to represent the time periods of post-privatisation, data of equipment performance was taken from May 1999 up to November 1999. This is taken by an assumption that during April 1999 the company had not been normal for the operation or by in other words the company was in a transition period and in December, when data was collected, the updating of performance data in that month had not properly finished. This period also reflected that economically Indonesia was facing an economic crisis. The data of the performance can be seen in its entirely in the following graphs:

Fig. 2.7.a The graph of MMBF and MTTR of container cranes in terminal I, 1999



Source: Jakarta International Container Terminal, Report of Equipment Performance, 1999c.

Fig. 2.7.b The graph of availability of container cranes in terminal I, 1999



From both tables it can be seen that when MMBF of CC in terminal I was very low, the availability level was very low as well. Container traffic at the moment was quite low, with 64,014 movements, so that maintenance could be done more intensively. The average availability inherent was very high with an average of 96%.

Fig. 2.8.a The graph of MMBF and MTTR of RTGCs in terminal I, 1999

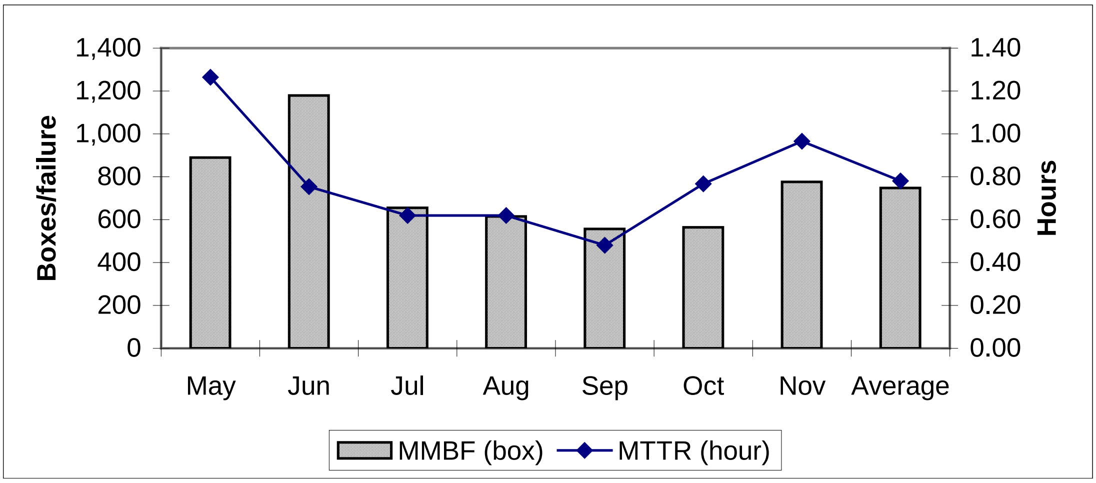
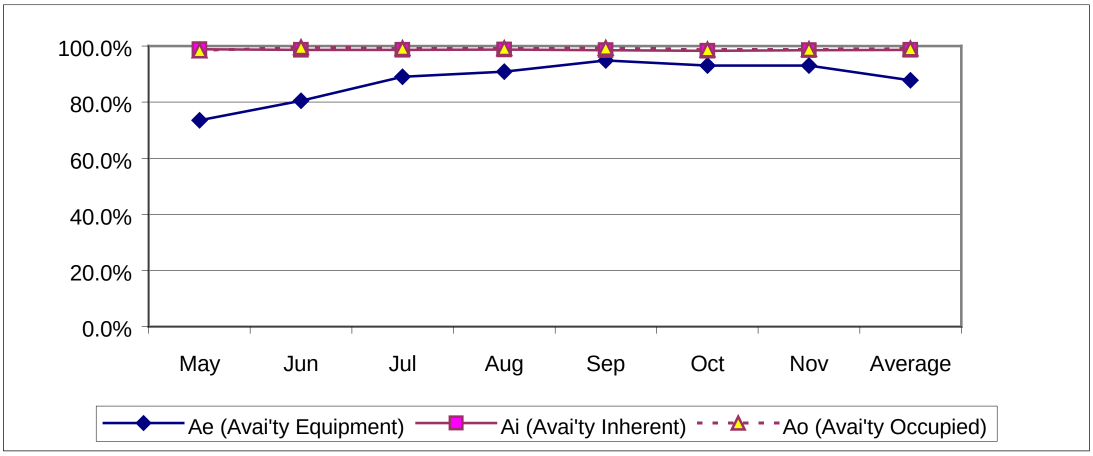
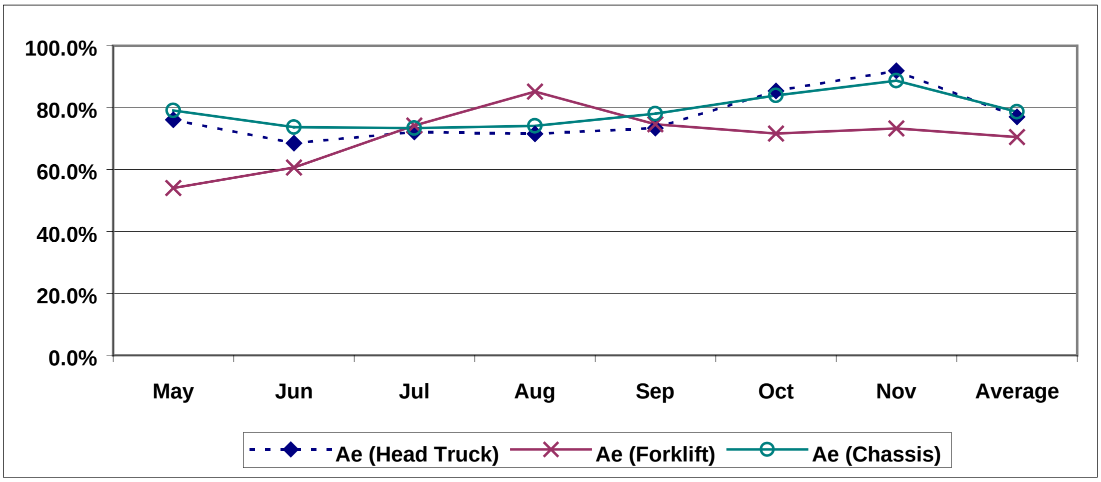


Fig. 2.8.b The graph of availability of RTGCs in terminal I, 1999



Availability inherent of those RTGCs was very high, on average 98%. Availability equipment in the beginning of the periods was quite low, which might be caused by the impact of the previous system.

Fig. 2.9 The graph of availability equipment of head trucks, forklifts and chassises in terminal I, 1999



The availability equipment of equipment types above (head trucks, forklifts and chassises) was quite low in the beginning periods. This seems also to be an impact of the previous management's policy in managing maintenance.

Fig. 2.10.a The graph of MMBF and MTTR of container crane in terminal II, 1999

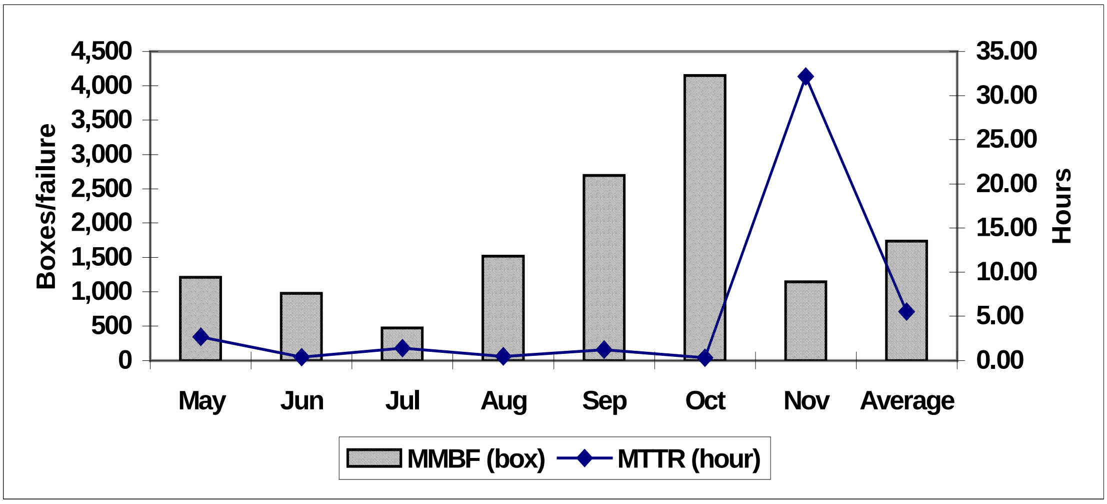
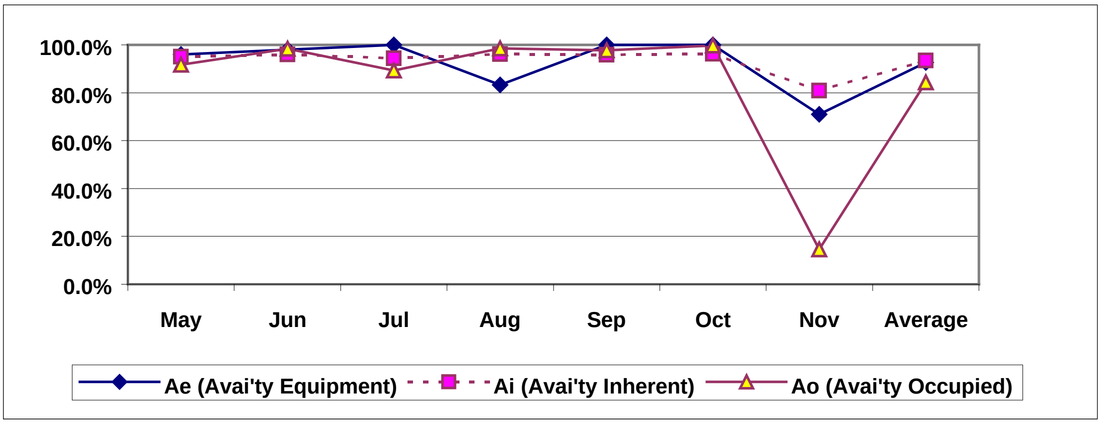


Fig. 2.10.b The graph of availability of container crane in terminal II, 1999



Although the average MMBF of CC of 1,739 boxes was very high, the MTTR of this CC in November 1999 was very high as well at 32 hours. This condition affected very much the equipment availabilities, whether availability equipment, inherent or occupied of that equipment.

Fig. 2.11.a The graph of MMBF and MTTR of RTGCs in terminal II, 1999

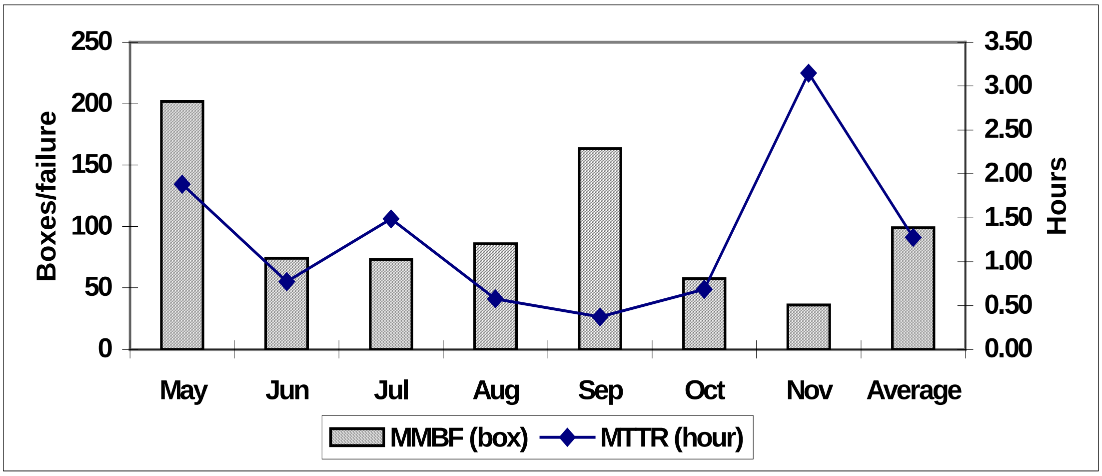
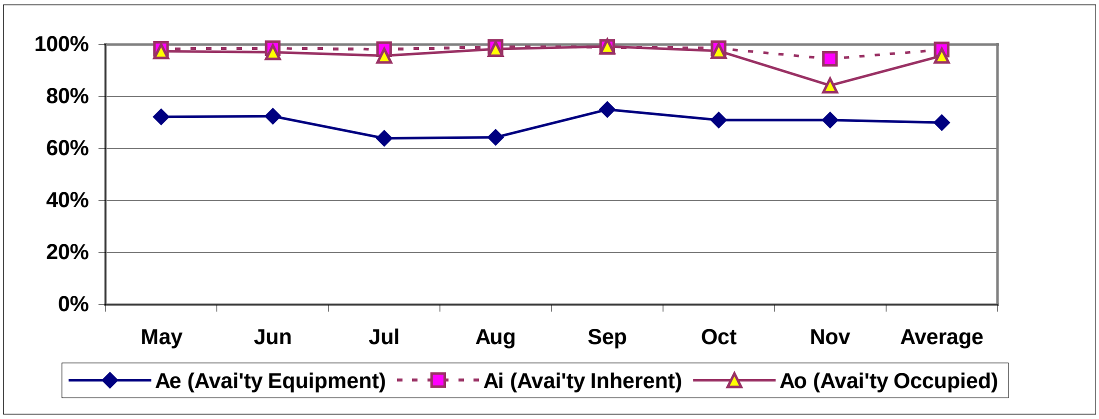
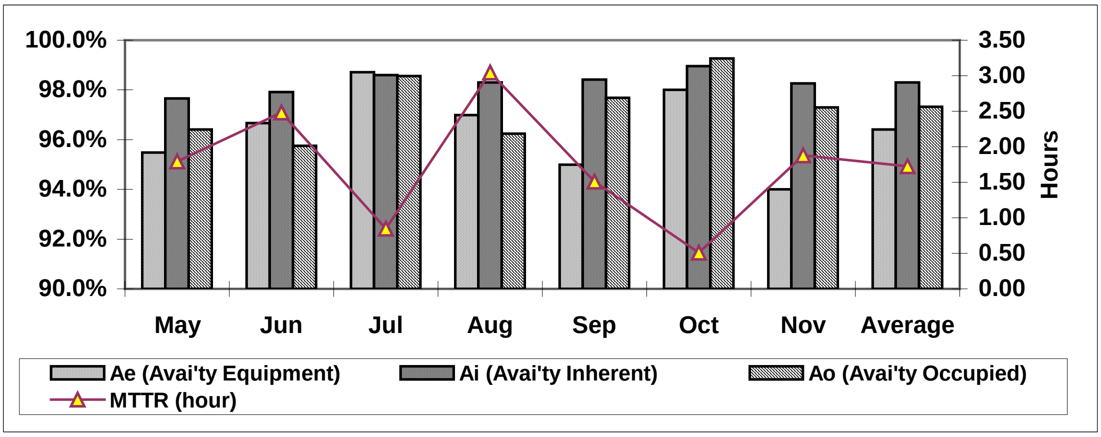


Fig. 2.11.b The graph of availability of RTGCs in terminal II, 1999



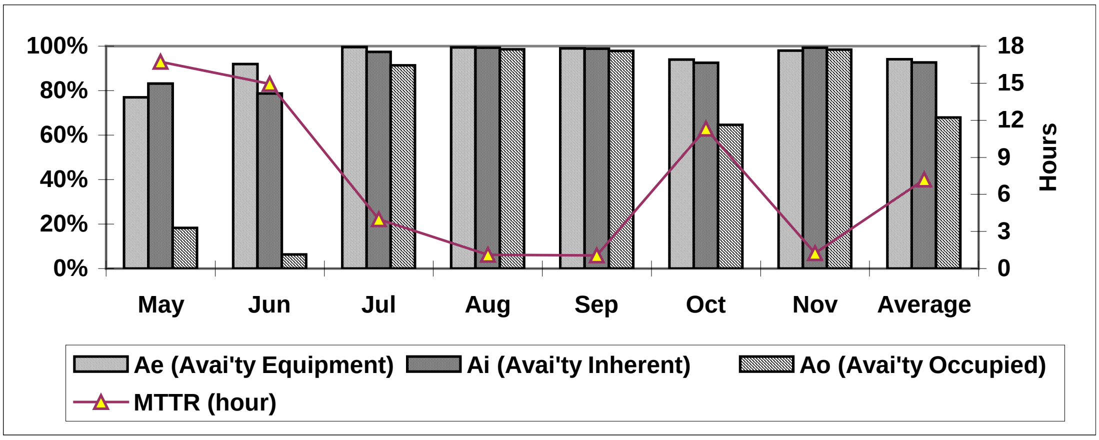
The average MMBF of those RTGCs during that period was 99 boxes, the MTTR was 1.3 hours and availability inherent was 98%. These figures of performance reflect that generally speaking the performance of this equipment was very good.

Fig. 2.12 The graph of performance of head trucks in terminal II, 1999



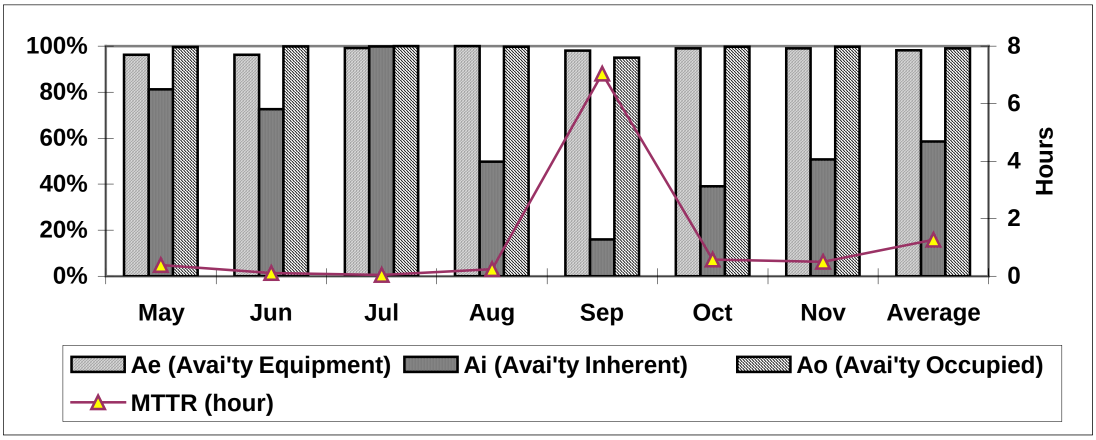
By looking at the graph above, the performance of head truck in terminal II was very good. The average availability equipment, inherent and occupied was more than 96% and the mean time needed to deal with each failure or break down on average was 1.7 hours.

Fig. 2.13 The graph of performance of forklifts in terminal II, 1999



In the first two months of the period, the availability occupied of those forklifts was very low; meanwhile MTTR was very on average 16 hours during the same period. The problem at the moment was the lack of some spare parts available which seemed to be an impact of the previous policy.

Fig. 2.14 The graph of performance of chassises in terminal II, 1999



Although the availability equipment and inherent was very high, on average 98% and 99%, the availability inherent of those chassis was quite low, on average only 58%. This problem was mainly caused by the lack of rubber-wheel availability. The management took the policy that the rubber wheels, which were installed to the chassises, were not new ones, but used ones which were taken from the head trucks' rubber wheels.

2.4 Summary

1. JICT applies RTGC system in its handling operation, which was applied by UTPK as well. This operation system requires many trailers to support the operation as well as container cranes and rubber-tyre gantry cranes. As the main equipment of the handling operation, the analysis focuses more on that kind of equipment.
2. In order to compare the two different management systems of UTPK and JICT, it is necessary to take into account the same time frame with the same economic situation which is faced by both UTPK and JICT, i.e., the economic crisis periods.
3. The changes of the management system impacts on the changes of the equipment performance indicators. Instead of availability inherent, which was traditionally used by UTPK, JICT adds availability occupied and availability equipment. The performance is also measured in order to reflect as close as possible the productivity of either the equipment itself or maintenance staff, by measuring MMBF and MTTR.
4. Generally speaking, the performance of equipment could be improved by JICT's management, for example the improvement of availability inherent and occupied ratio, and the reduction of MTTR, which are indicated in the graphs above. Even though there are some improvements, the trend is not clear due to the short period of recording data, that is eight months. The factors affecting the improvement will be discussed in the following chapter.

CHAPTER III

ANALYSIS AND EVALUATION OF EQUIPMENT PERFORMANCES FROM VARIOUS POINTS OF VIEW

3.1 Introduction

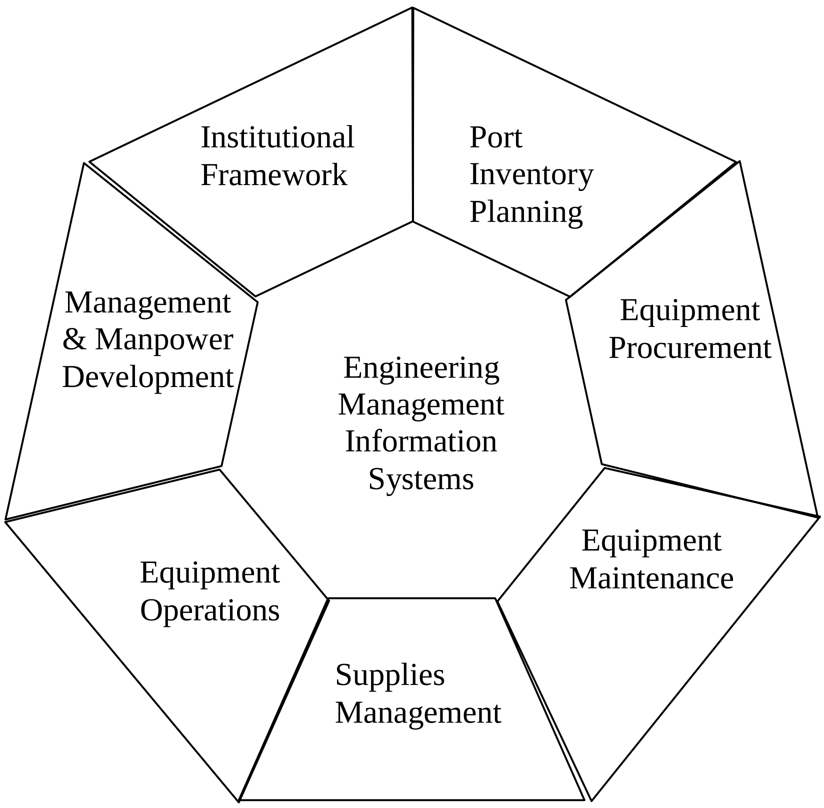
In most port organisations, the role of the port engineering department is to provide and maintain, to a high standard, the port's civil work and infrastructure, its marine craft and navigational aids, its cargo-handling equipment and its technical services (Thomas, 1989). This means that the engineering services do not merely mean the end of providing a full supportive operational activity of the ports to serve the needs of port users. Even though the engineering department is not directly involved in serving a port's customers, it has a vital role to achieve the organisation's objectives.

Along with the development of technology, equipment is becoming more and more sophisticated. As the first person who faces failure, the machine operator attempts to repair a machine. Together with the development of technology, equipment has become much more complex, leading to the requirement of special skills, tools, equipment and materials for repairs and operation. These typical requirements are almost impossible to be met by the operators themselves. Therefore, to deal with this modern and more complex equipment there is a need for well-trained maintenance staff as well as operator staff.

Moreover, equipment maintenance and operation need to be overseen by a particular type of management department, namely maintenance management department. UNCTAD (1990) in the handbook of Improvement of Port Performance 3, states that equipment management is composed of eight elements:

- port inventory planning,
- equipment procurement,
- equipment maintenance
- supplies management
- equipment operations
- management & manpower development
- institutional framework, and
- engineering management information systems.

These eight equipment management elements can be illustrated in the following figure:



Source: UNCTAD, 1990, IPP3

Fig. 3.1 Equipment Management Elements

These individual elements are interdependent on each other. The failure of implementing or organising one element of activities may lead to deficiencies or problems in others (Thomas, et. al, 1989). This means that the success of the overall management function depends on the strength and qualities of those elements. According to the above elements, this chapter will try to analyse the performance of container handling equipment from point of view of these elements, to find out the problems which might be faced and the alternative solutions of the problems as well.

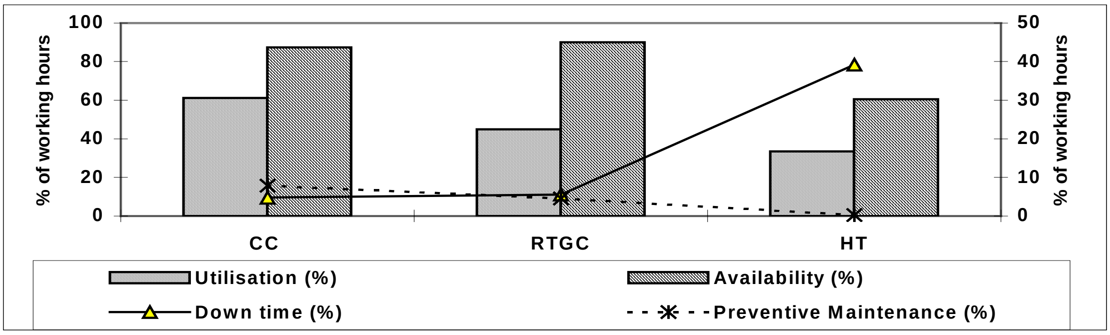
3.2 Analysis of Equipment Performances before Privatisation

3.2.1 Equipment operation

3.2.1.1 Terminal I

In chapter 2, the graph of equipment performance was shown. Generally speaking, the availability of CC and RTGC in terminal I during 1998 was relatively stable. The average performance of equipment during 1998 can be illustrated in the following graph:

Fig. 3.2 Graph of average equipment performances in terminal I, 1998



From the graphs above, it can be seen that break time for head truck during the period of 1998 was very high, due to the lack of spare parts available, which led to the lack of preventive maintenance as well.

The availability of equipment can be calculated by using the following formula:

$$Av = \frac{(n \times \text{number of days in present month} \times 24) - \sum_{i=1}^{n} PMi - \sum_{i=1}^{n} DTi}{(n \times \text{number of days in present month} \times 24)}$$

Av = Availability

n = number of machines (equipment)

$\sum_{i=1}^{n} PMi$ = total time needed for executing preventive maintenance program

$\sum_{i=1}^{n} DTi$ = total time needed for dealing with down time

Operationally, the management of UTPK determined that the operation time was divided into three shifts per day and each shift was employed for eight hours with one-hour pause time. This means that the working hours in UTPK was 21 hours per day. The terminal was also open 7 days per week. Although operationally the working hours was 21 hours per day, the Engineering Division of UTPK determined that the working hours for equipment in terminal I was 24 hours per-day and 7 days per-week. The main reason why the Engineering Division decided on such a policy was that the main power installed for container cranes in terminal I was the diesel engine.

The characteristic of the diesel engine is that it needs time to idle up or to achieve the maximum power capacity when it starts to run. Instead of being switched-off during the one-hour pause time, CCs were allowed to be run on. By taking the assumption that it needed 20 minutes to allow the engine to achieve its maximum power capacity, this meant that operationally the handling of five to six boxes of container per CC would be lost. This condition could be explained as followed:
By combining fig. 3.2 above and terminal I throughput in 1998 (table 1.2 chapter I) it could be assumed that the productivity of the container crane in terminal I was:

- Total throughput in 1998 in the terminal I = 755,953 boxes

- Average utilisation of CC in 1998 = 61%
- Number of CC employed in the terminal I = 8
- Number of MHC employed in the terminal I = 3

Practically, three MHCs were employed in one berth and each of the remaining berths employed two CCs. This meant that three MHCs could be assumed as two CCs; therefore, terminal I employed 10 CCs. Utilisation of 61% meant that the total worked-hours which had been utilised by each CC was:

(61% x 365 x 24) hours = 5,343.6 hours.

The worked-hours is defined as total time which is recorded by machine-hour-meter to serve operations during a specific period (daily, weekly, monthly or yearly). In fact, the worked-hours of CC was less due to the difference of three hours between the operational and engineering departments in determining service hours. The actual worked-hours of each CC according to the operational point of view was:

$$5{,}343.6 - (3 \times \frac{5{,}343.6}{24}) = 4{,}675.65$$

The total worked-hours of 8 CCs and 3 MHCs, which was assumed to be similar to two CCs, was 46,756.5; therefore, the average productivity of CCs was:

(Total throughput/total worked-hours) = 755,953 / 46,756.5

$\approx$ 17 boxes/CC/hour.

By allowing the engine not to be employed for 20 minutes after pause time meant that they would lose the handling of six boxes of containers. The cheapest tariff of container handling at the moment was US$ 62/boxes, i.e., the tariff for handling a 20' empty container (UTPK, 1998). This meant that they would lose an opportunity revenue of US$ 372 for not employing one CC for 20 minutes.

The cost of allowing an engine to be run for one hour can be explained as followed:

- The fuel consumption of a diesel engine is 180 grams per-HP per-hour (de Heer, 2000, p.18).
- Maximum engine horse power capacity was employed to CC = 2095 (for new engine Caterpillar D.3516 TA)
- The fuel consumption for running the engine for one hour = (180 x 2095) grs.

  = 377 kgs.
- Specific gravity of diesel fuel = 0.85 kg/litres
- The volume of diesel fuel needed for running the engine for one hour ≈ 444 litters.
- The price of diesel fuel in Jakarta at the moment = US$ 0.1/litter.
- The fuel cost needed for running the engine for one hour = US$ 44.4
- The cost of lubricant assumed as a percentage of fuel cost (de Heer, 2000, p.20) was normally no more than 10% of the fuel cost.

By comparing both calculations, it could be said that by allowing the engines to be run on during one-hour pause time was better than switching-off the engine. This was why the Engineering Division of UTPK applied a 24 hour working-period for equipment in terminal I, instead of 21 hours.

During the periods of April and May 1998, from 59 HTs in terminal I, the availability time of that equipment was 23% and 33% only. This meant that HTs were only available to be utilised on average 5.5 and 8 hours or 324.5 HT-hours and 472 HT-hours per-day. The total throughput during those periods was 61,823 boxes and 56,578 boxes (table 1.2 chapter 1); therefore, the daily throughput of the terminal was 2,061 boxes and 1,825 boxes. Supposing the handling rate of CC was 17 boxes/hours and the availability time of that equipment was 90% and 93% at the moments, the total CC-hours needed in April was:

$$\text{CC-hours} = \frac{2{,}061}{17 \times 0.9} = 135\ \text{CC-hours}$$

and in May was:

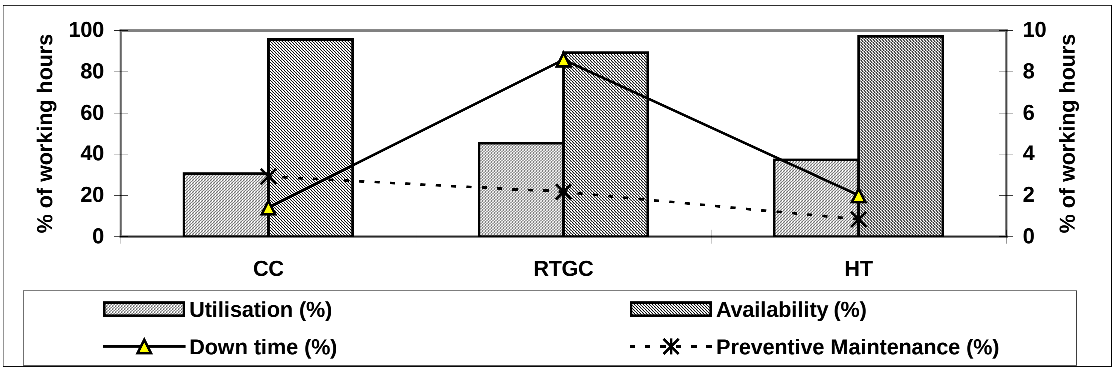
$$\text{CC-hours} = \frac{1{,}825}{17 \times 0.93} = 115\ \text{CC-hours}$$

The management of UTPK decided to serve one CC by 3 RTGCs and 5 HTs; therefore, everyday they needed 675 HT-hours during April and 575 HT-hours during May 1998. In order to cover the lack of HT-hours available, UTPK took action by leasing trailers from another company.

3.2.1.2 Terminal II

The average equipment performance during the periods of 1998 can be seen in the following graph:

Fig. 3.3 Graph of average equipment performances in terminal II, 1998



In terminal II, UTPK employed service time of 21 hours per-day and seven days per-week applied either to the operational division or engineering division. This was mainly due to the nature of CCs which were employed in the terminal. The CCs used the electrical generator as the main power. Due to this condition, the formula for availability therefore becomes:

$$\text{Av} = \frac{(\text{n} \times \text{number of days in present month} \times 21) - \sum_{i=1}^{n} PMi - \sum_{i=1}^{n} DTi}{(\text{n} \times \text{number of days in present month} \times 21)}$$

Av = Availability

n = number of machine (equipment)

$\sum_{i=1}^{n} DTi$ = total time needed for executing preventive maintenance program

$\sum_{i=1}^{n} PMi$ = total time needed for overcoming down time

In addition, the productivity of CCs in terminal II which was relatively low compared to the productivity of terminal I, was the other reason to determine this service time. From fig. 2.4 chapter II, it can be seen that the average utilisation of CC in terminal II was 30.67%. This meant that the total worked-hours of each CC was:

30.67% x 21 x 365 ≈ 2,351 hours.

By combining table 1.2 in chapter I and fig. 2.2 in chapter II and by taking an assumption that an MHC is similar to 0.67 CC, it can be calculated that the productivity of each CC was:

212,090 / (2,351 x 5.67) ≈ 16 boxes/CC/hour.

Evaluation

By combining the utilisation and the productivity of CC in terminal II, it can be said that operationally the utilisation of those CCs could be improved. However, according to the depth of the quay in terminal II, which is –9 meters only, the improvement might be very difficult due to this barrier.

3.2.2 Institutional framework and equipment procurement

From the organisational structure of the equipment maintenance department of UTPK (Fig. 1.1, Chapter I), it can be said that the maintenance department is totally separated from the operational department. For the lower level, the operator staff are in a different organisation from the maintenance staff, whereas the equipment operators should be involved in the maintenance process, at least for the daily maintenance.

Indonesia Port Corporation II, Ltd. is a State-owned company. Operationally, it largely depends on government regulations. Tariff policy, tax regulations, control of investment and capital budgets are examples. UTPK, an organisation under the Indonesia Port Corporation II, Ltd., was largely affected by government regulations as well. Maintenance matters, such as equipment purchase, spare parts procurement and employment of external consultants are some examples which were largely affected by the regulations.

One regulation which very largely affected maintenance-matter activities was *Keputusan Presiden RI No. 16 Tahun 1994 (Keppres. No. 16/1994)* or The Presidential Decree of the Republic of Indonesia Number 16, 1994. This regulation arranged the procedure of procurement either for goods or consultant services in governmental institutions and all State-owned companies. The arrangements were divided into three categories (Bappenas, 1994):

a. For the procurements which were less than Rp. 15,000,000.00, which was equal to US$ 2,000, the company could directly pointed out to a supplier, contractor or sub-contractor to execute those of the procurements.
b. For the procurements' value between Rp. 15,000,000.00 to Rp. 50,000,000.00 (or US$ 2,000 to US$ 6,700) the company could select a supplier, contractor or sub-contractor to execute those of the procurements. Before selecting the contractors, those contractors had to make a proposal regarding the price of procurements.
c. For the procurements which were more than Rp. 50,000,000.00 or US$ 6,700, the company had to openly tender the projects to suppliers, contractors or sub-contractors in order to find the selected party. In terms of determining the selected party of the participants' tender in Indonesia Port Corporation II, Ltd., the tendering was divided into three categories in accordance with the value of projects. These are:
    - The value of Rp. 50 millions up to Rp. 500 millions (or US$ 6,700 up to US$ 66,700), the decision could be approved by the Head of Port Branch Office or the Head of Unit Office.

- The value of Rp. 500 millions up to Rp. 10 billions (or US$ 66,700 up to US$ 1,333,300) the decision had to be approved by the Directors of the Indonesia Port Corporation II, Ltd.
- The value of more than Rp. 10 billions (or more than US$ 1,333,300) the decision had to be approved by *Badan Perencanaan Pembangunan Nasional (Bappenas)* or National Development Planning Agency, a national body which is in charge of the planning of development in Indonesia.

In order to implement that regulation, the management of UTPK set up two special working teams or committees, namely the committee of direct-selection and the committee of tendering. The members of these committees were composed of inter-discipline departments or divisions, namely the engineering departments, finance departments, legal and insurance department, operational department and personnel and general affairs department.

Practically, the process and procedure of the procurements took quite a long time, very often up to one-month, even longer. This condition very largely affected the performance of equipment. The delay of equipment spare parts was one example, which was the affect of a lack of parts available in the inventory. One impact which very largely affected the performance of equipment could be seen in the performance of the head truck in terminal I in 1998 (fig. 2.4 chapter II). During the first semester of the year, the availability of the head truck was very low, on average 47%. On the other hand, the down time of that equipment was very high during the same periods, even up to the first-nine months of the year on average 46%. The main cause of the high down time was the lack of the head truck's rubber-wheel (UTPK, Engineering Division, 1999). The situation also happened to RTGC in terminal II due to the unavailability of some electrical parts which had to be imported from the manufacturer's country. In addition, the policy of the government regarding the currency policy also greatly affected the purchasing process, especially for parts which had to be imported from abroad and had to be paid for by foreign currency.

3.2.3 Equipment maintenance strategies and practices

Sometimes there is misinterpretation when people try to distinguish maintenance and repairing, although in fact these two activities are generally under the responsibility of one department, i.e., maintenance and repair (M&R) department. Bachrun (1993) defined maintenance and reparation as follows:

> "Maintenance is a regular activity in regards to the facility which is repeatedly done in order to keep that facility in a such condition as well as its new condition. Reparation can be defined as a restoration in regards to the facility in order to approach as close as possible to the new condition by replacing its spare parts, doing overhaul or reprocessing its material which has been deteriorated" (p.4).

The methods which are very often practised in organising maintenance are preventive maintenance (PM), corrective maintenance (CM) and break down maintenance. UNCTAD (1983) defined that "preventive maintenance (PM) as the regular-maintenance activity which is done periodically in the basis of worked hour or calendar in order to prevent facilities or equipment from failure during its operation" (p.10). Warming & Hazama (1985) defined that "corrective maintenance as the activity of maintenance which is taken as the outcome of investigation or corrective of the breakdown" (p.19). Breakdown maintenance was defined by Bachrun (1983) "as the action which is taken in regards to the facility or equipment when they fail or been breakdown" (p.48).

The strategy which was mainly taken by UTPK in organising maintenance was preventive maintenance (PM). In practice the maintenance was taken on the basis of equipment worked-hours, which mainly refers to the manufacturer's recommendation. The regular inspection was done periodically every 200 up to 250 hours, 600 up to 750 hours, 2,400 up to 3,000 hours and 6,000 up to 9,000 hours (UTPK, 1998). In order to more concentrate its human resources on doing maintenance, UTPK contracted out some major maintenance, mainly engine overhaul, to another company.

In terms of equipment age, there were at least 15 cranes, either shore or yard cranes, which were more than 10 years old. Following is the table of the ages of those cranes either in terminal I or terminal II:

Table 3.1 Data of shore and yard cranes with an age of more than 10 years in UTPK, 1998

Register Number	Manufacture/ Brand	Location	Year of product	Year of retrofit
CC 01	Sumitomo	Terminal I	1983	1998
CC 02	Sumitomo	Terminal I	1976	1998
CC 03	Sumitomo	Terminal I	1976	1997
CC 01A	Mitsui	Terminal II	1972	1997
CC 02A	Mitsui	Terminal II	1972	
TT 01A	Paceco	Terminal II	1979	1995
TT 02A	Paceco	Terminal II	1979	1996
TT 03A	Paceco	Terminal II	1979	
TT 04A	Paceco	Terminal II	1979	
TT 05A	Paceco	Terminal II	1976	1996
TT 06A	Paceco	Terminal II	1979	
TT 07A	Paceco	Terminal II	1979	
TT 08A	Hyundai	Terminal II	1988	1996
TT 09A	Hyundai	Terminal II	1988	1996
TT 10A	Hyundai	Terminal II	1988	1996

Source: UTPK, Data and Information, 1998

In terms of the old equipment, instead of purchasing new CCs for replacing that equipment, UTPK took action by doing a retrofit as one of the strategies in organising maintenance. Retrofit is the process of renewing equipment by totally checking, repairing and replacing all parts of that equipment when necessary in order to improve the condition and reliability of the equipment as close to the new condition as possible. By using this strategy, the reliability of equipment could be improved up to 90% compared to the new condition (UTPK, 1998). Saving money was another advantage as well, instead of spending money for purchasing new equipment. The impact of the implementation of retrofit practice can be seen in the fig. 2.2 and fig 2.3 chapter II. In these figures, the graphs of PM (preventive maintenance) for CCs and RTGCs in terminal I in the beginning of 1998 was very high.

3.2.4 Equipment-spare-parts inventory planning

As mentioned in the sub-chapter on institutional framework, the procurement of either equipment-spare-parts or the equipment itself as a new investment, is very largely affected by government regulation. In addition, this condition affected spare-part inventory planning.

The age of some equipment which was relatively old, especially CCs and RTGCs, is another barrier in organising spare-part inventory planning. By doing retrofits, the cranes were allowed to use up-to-date technology, which is normally easier to procure the parts; therefore, it is easier to plan the spare-part inventory. Another advantage of practising the retrofit system is that equipment can be standardised, which makes it easier to plan and organise the maintenance program as well.

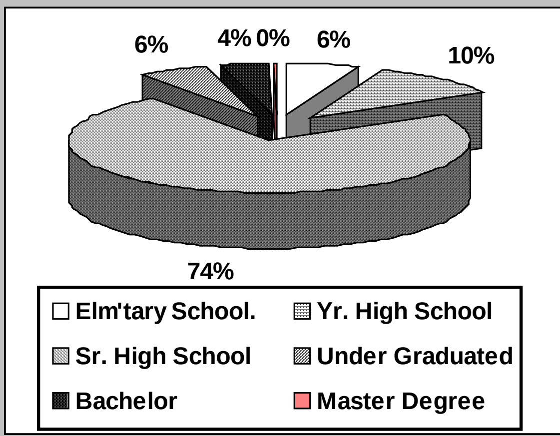
3.2.5 Management and manpower development

By looking at the organisational structure of UTPK, it can be seen that the operation and engineering departments were separated. Equipment operators were under the responsibility of the operation department, meanwhile the equipment belonged to the engineering department.

UTPK divided operations into three shifts per-day and seven days per-week. In order to keep and monitor equipment during night-time, the engineering department set up a group unit staff, namely equipment emergency group, into three shifts as well. The equipment emergency group consisted of the combination of maintenance sub-section staff. This is one solution which was taken by the management of UTPK to involve equipment maintenance staff in operations.

UTPK employed 1,230 staff composed of 978 persons in charge of direct and supportive operations, and the remaining 252 persons in charge of administration. Supportive operational was defined as the staff of the divisions other than operational divisions who support the operational activity, for example equipment maintenance staff. For the equipment maintenance staff, UTPK employed 145 persons. From the education point of view, the staff could be divided as in the following graph:

Fig. 3.4 Distribution of human resources in UTPK 1998 according to education level



From the graph above, it can be seen that UTPK's staff was dominated by people with Senior High School level, that is 74% or 909 persons. Generally speaking, that education level was not quite competent enough to deal with either operation or equipment maintenance matters; therefore, experience and additional technical-skill training was needed for those persons in order to be competent. In the engineering division for example, a new engineer who had just been recruited should directly practise in maintenance jobs for at least one year in order to get more experience.

In terms of training, UTPK did not have an absolute autonomy to organise training programs. All programs were arranged and programmed by the Sub Directorate of Human Resources Planning and Development (Subdit HRPD), Directorate of Personnel and General Affairs, the head office of Indonesia Port Corporation II, Ltd.

(UTPK, 1998). This was another barrier for UTPK to develop its manpower, whereas Subdit HRPD organised and arranged training not only to meet UTPK's needs, but also for the whole company. One thing that UTPK could do was to include training programs into purchasing equipment or outsource working contracts between UTPK and its contractors. By this method, UTPK could prepare its manpower in order to adopt the new technology which would be employed.

In terms of operator skills, in order to create competent operators, IPC II, Ltd. provided a crane simulator and organised the training itself. The head truck or forklift operators could be promoted by involving them in this training program. The trainees could also be taken from maintenance staff. The advantage of employing equipment maintenance staff as the operator staff was that they had become familiar with that equipment.

3.2.6 Engineering management information system

IPC II, Ltd. installed an intranet system among the port's branches and unit located in Jakarta, those are, UTPK, Port of Tanjung Priok Branch and the head office of IPC II. The intranet was built in order to accommodate a management information system of operation, finance, human resources and engineering. With this system, the top management level of IPC II could know and access the situation and take decision as required.

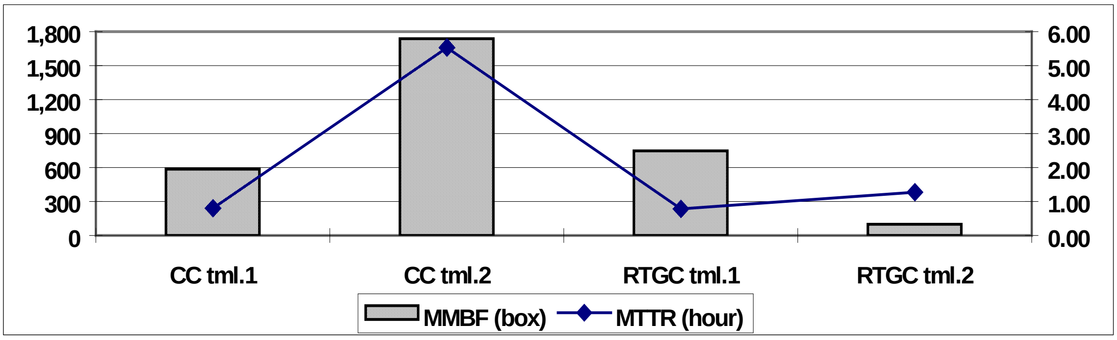
The implementation of an Engineering Management Information System allowed the equipment manager to directly give information related to equipment matters to either the management of UTPK itself or IPC II. All of the equipment performance indicators, i.e., availability, utilisation, down time, had to be up-dated everyday. Monthly reports of equipment performances were submitted to all persons at the top management level either in UTPK or in IPC II, Ltd. in order to be evaluated. Action would be taken if necessary.

3.3 Analysis of Equipment after Privatisation

3.3.1 Equipment operation

Related to the operation, equipment performance was measured by determining the mean number of movements between failure (MMBF) instead of mean time between failure (MTBF). MMBF can more reflect the real productivity of equipment rather than MTBF; in addition, the achievement of the maintenance staff can be measured as well. Another equipment performance indicator is mean time to repair (MTTR). MTTR reflects the achievement of maintenance staff in organising maintenance. The average MMBF and MTTR of either CCs or RTGCs in terminal I during the periods after privatisation can be seen in the following graph:

Fig. 3.5 Graph of average MMBF and MTTR of CCs and RTGCs in terminal I, 1999



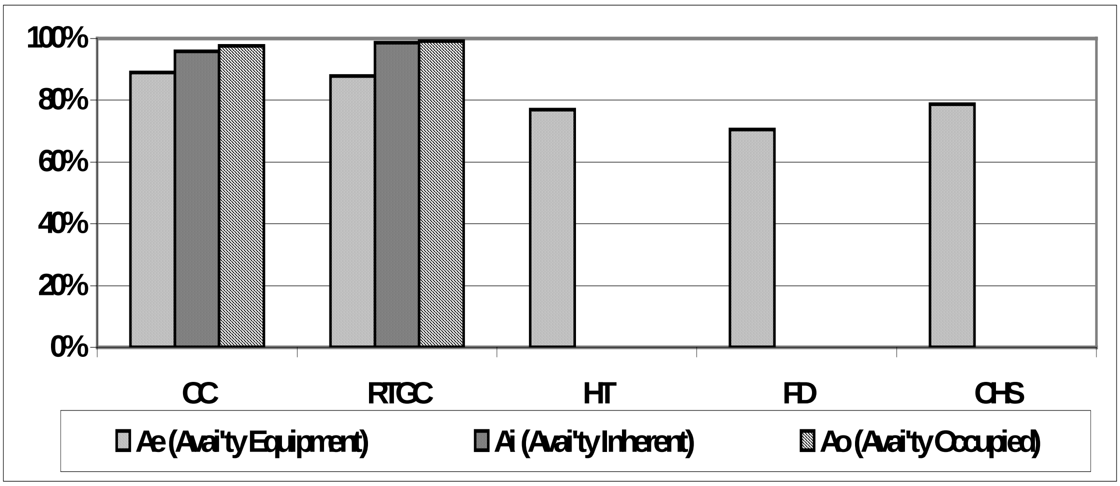
Note : - CC tml.1 : CC in terminal I - CC tml.2 : CC in terminal II
- RTGC tml.1 : RTGC in terminal I - RTGC tml.2 : RTGC in terminal II

From the graph above, operationally, the achievement of equipment performance in terminal I was very good. In that terminal, the mean number of movements between two failures of CC was 587 boxes and for RTGC was 748 boxes. The mean time needed to deal with each failure was less than one hour for both types of equipment. In terminal II, MMBF of RTGC was not too good, on average 99 boxes only. Nevertheless, this achievement in general was quite good, being an outcome of implementing the new concept of equipment management, such as involving engineering as a sub-department of the operation department, so that co-ordination between operators and maintenance staff could be improved.

3.3.2 Equipment maintenance strategies and practices

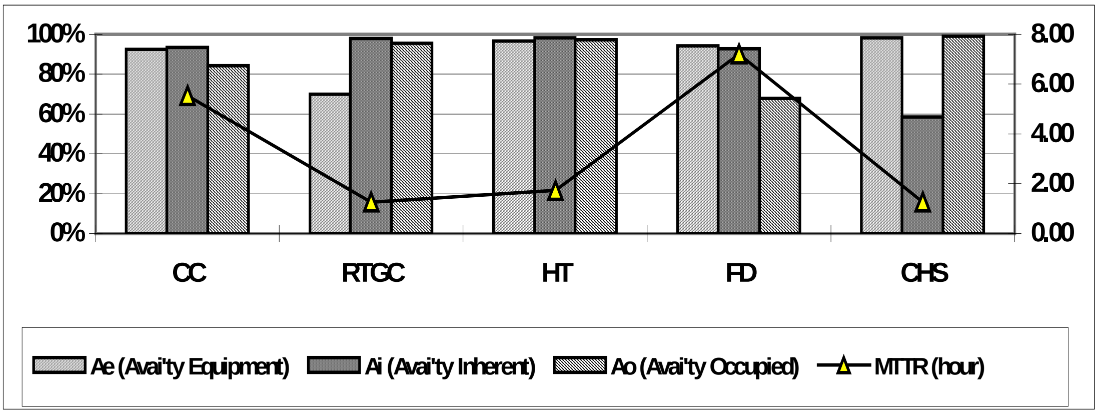
Basically, JICT has not changed the maintenance strategies which used to be done by UTPK, that is doing all preventive maintenance by themselves. One quite big difference that JICT did make, however, was that they co-operate with the engine supplier. Instead of contracting out engine-overhaul work, JICT asked the supplier to provide their engine to be changed with JICT's engine by selling and buying system♣. JICT sells the used engine to the supplier and buys a new one or the overhauled one. This practice seems to significantly shorten the idle time of the equipment. Instead of waiting two, up to three weeks to do the overhaul, the machines only need one, up to two days, to loosen and re-installed the engines. In addition, this selling and buying practice system could also reduce the inventory level of back-up engine and spare parts, so that the capital cost and inventory cost could be reduced. In this case, JICT seems to successfully implement this method, as indicated in the following graphs:

Fig. 3.6.a Graph of average equipment availability in terminal I, 1999



♣ Source: Interview with Equipment Maintenance and Repair Manager, 20 December 1999.

Fig. 3.6.b Graph of average equipment availability and MTTR in terminal II, 1999



From those two graphs, it can be seen that availability inherent, which is also measured and named availability by the previous management (UTPK), on average more than 95% for each type of equipment, except availability inherent of chassis in terminal II, on average 58% only.

Even though the capital and inventory costs could be reduced and saved, it does not mean that the running costs for maintenance could be reduced as well. This is one of the disadvantages of implementing these systems. The cost of selling and buying or contracting out major engine overhaul work must cover labour costs and tax. By practising this overhaul job by itself, at least JICT could save money from tax and labour costs, due to the labour salary covering all of the labour responsibilities.

3.3.3 Institutional framework, supplies management and equipment procurement

As a private company, JICT has an absolute right to determine which company is to be pointed out to meet the needs of goods or service procurements, without depending on government regulations. Practically, JICT can try to find out the method of procurement by itself. In order to meet this need, JICT has set up a specific institution which has the responsibility for any procurement, namely the procurement department (see fig. 1.2 chapter I).

The factors that JICT should consider to point out to the supplier, contractor or sub-contractor to execute the needs of those procurement needs were price and delivery time[♣]. Operationally, JICT should consider whether the execution of this procurement has a direct impact on the operational matters or not, especially from the delivery time point of view. The impact of implementation on this method very positively improved its equipment performances, which can be seen in figs. 3.5.a and 3.5.b above. It seems that this practice could minimise the lack of spare parts available in the inventory, which often happened during the previous management.

In practice, the approval of procurement was taken by the JICT's management only, depending on the number of budgets they have, those are[♦]:

- The budget up to US$ 64,500 should be approved by the President Director
- The budget up to US$ 30,000 should be approved by the Operation Director
- The budget up to US$ 10,000 should be approved by other Directors
- The budget up to Rp. 5,000,000 or US$ 700 could be approved by the Senior Manager Engineering
- The budget up to Rp. 4,000,000 or US$ 550 could be approved by the Accounting Manager.

The implementation of this approval system could very largely shorten the time of the purchasing process, so that the delivery time could be speeded up.

In terms of organisational structure, the division of supervisor which is based on the work area and the type of equipment seems not to reflect the specialisation of jobs in a particular field, those are mechanical, electrical and hydraulic. This condition seems to be less effective both from the professionalism and efficiency of employment points of view.

[♣] Source: Interview with Procurement Manager of JICT, 20 December 1999.

[♦] Source: Memorandum of Finance Director of JICT to President Director, other Directors, Senior Manager of Engineering and Account Manager of JICT about Approval of Purchase, 03 December 1999.

3.3.4 Management and manpower development

In the beginning of the periods, the management sent some of either the maintenance or engineer staff to the ports which are operated by Hutchison Port Holding to learn the method and working ethics being practised by the management. This effort was to change the traditions of those staff to be private oriented thinking.

In order to develop maintenance staff, management recorded training skills which had been given to each individual staff member and planned further training that should be given. Electrical, mechanical and hydraulic skills are the main subjects that the staff should be competent in.

Basically, the privatisation of JICT involves taking over all of the assets, including human resources or labour. In terms of the composition of human resources education level, there is no big difference between UTPK and JICT human resources; therefore, the personnel need to be trained as well in terms of technical skills.

3.3.5 Engineering management information system

Another system that seems to contribute to the improvement of those performances is the implementation of a fault code system. Every fault was identified by a certain code in order to simplify the tracking of equipment history. This information was very important for the equipment M&R manager to evaluate, plan and make decisions in order to improve those performances.

The difference of practising this system was that the management did not install the intranet system anymore, which used to be used by the previous management. Instead of practising this system, the management employed an expertise advisor in the engineering sub-department, especially in the equipment maintenance section. The employment of this advisor was for a short term only, but in the long term, JICT will install an integrated Information Technology system which can accommodate the information system of operation, finance, personnel and engineering. The responsibility of this advisor is to assist the equipment maintenance and repair manager, and to give information to the higher level of management regarding maintenance matters. The practice of this system seems to be less simple, but in fact it could more motivate the maintenance staff to exploit their performance.

3.4 Summary

1. The low performance of equipment under UTPK's management was mainly caused by the lack of spare parts available in the inventory. This condition seemed to be a result of the institutional framework with government regulations which should be followed by all state-owned companies, especially the regulation of equipment and spare part procurement.
2. JICT as a private company does not have to follow government regulations related to equipment, spare parts and service procurements. This practice leads JICT to simplify its procurement procedure, so that the lack of availability spare parts can be avoided. Furthermore, this practice leads to improvements in the performance of equipment.
3. Although the achievement of equipment performances can be improved, there are some practices that need to be evaluated in order to be accepted by the maintenance staff. These efforts might lead JICT to find an ideal maintenance management model.

CHAPTER IV
MAINTENANCE SYSTEMS IN VARIOUS PORTS IN EUROPE

4.1 Introduction

Port equipment maintenance can critically determine the reputation of ports. Shipowners as port users can decide to call at a port by using it as a serving feeder or direct line-haul service depending on its reputation. The poorer the equipment performs, the longer the ship turnaround time is likely to be. This factor of turnaround time often becomes a critical factor for shipowners to call at a port.

Maintenance is obviously not the only factor affecting ship turnaround time, although shortage of equipment could be a major contributor to low output. In terms of this long ship turnaround time, shipowners often apply additional surcharges to compensate the cost arising from this condition which should be paid by shippers and cargo owners. Moreover, this additional surcharge could decrease the competitiveness of the ports.

What have the major ports in Europe actually done so that they can achieve a high competitive level? This chapter will try to study and analyse what they have done from the equipment-maintenance point of view.

4.2 Maintenance Policies

Basically, the maintenance policies that the ports around the world apply are three types, namely preventive maintenance (PM), corrective maintenance (CM) and designing out maintenance (Toubhans, 1999).

4.2.1 Preventive maintenance

The preventive maintenance that the port implements is characterised by a repetitivity of tasks and high number of tasks. Practically, the management divides preventive maintenance into two systems, that is systematic preventive maintenance and condition-based maintenance.

Systematic preventive maintenance is based on fixed time interval (yearly, monthly, weekly or daily). This type of maintenance is profitable for the replaced-components which are cheap or when the consequences involved by a failure are severe, for example:

- Lubrication and oil changes
- Tightening of clamps
- Checking of safety devices
- Inspection on lifting cables
- Inspection on brake-pads

This type of policy is easy to carry out, but it has shortcomings for equipment where lifetime heavily depends on the time of use. For this particular case, condition-based maintenance could be an alternative way.

Condition-based maintenance is the checking of the various components which is determined if an intervention is necessary. In other words, a component would be changed only if it is necessary. The most frequent checks concern:

- While equipment is being used:
  - ➢ Vibrations
  - ➢ Temperatures
  - ➢ Warning lights (for brake)
  - ➢ Pressure levels
- While equipment is not being used:
  - ➢ Oil analysis
  - ➢ Visual check

- Measurement of functional play

This type of policy needs the purchase of sensors or adequate measuring equipment; therefore it is more appropriate where the components are expensive to change.

4.2.2 Repair on breakdown

Repair on breakdown or corrective maintenance is the type of maintenance which is carried out when the parts fail to function. This method could be justified from the economic point of view for cheap components which are easy to replace. This practice can be done only when skilled staff are available and preventive maintenance can not be done when there is pressure from the operation activity. The difficulties that the port faces are to make a diagnosis in the shortest possible time and to evaluate very quickly the time needed for repairs.

In order to deal with those difficulties, the solutions that the Port of Le Havre, France, has arrived at are:

- Specialist training for the workers involved in the diagnosis.
- Programmable logic control supervisor to locate the origin of the problem.
- Some staff should understand the process of equipment installation.

4.2.3 Repair of components

Repair of components or design out maintenance is characterised by the complexity of the tasks, special tolls that are needed and highly skilled manpower. This method has difficulties, e.g., to carry out maintenance in depth repair, to determine the root cause of the trouble and to find a solution to fix the cause. In order to deal with the problems, what the Port of Le Havre has done is to train the workers by involving them in the major repairs and to implement computer assisted maintenance control (CAMC).

4.3 Maintenance Strategies

There are two strategies that ports in Europe have employed in organising maintenance policies, namely on site maintenance and contracting out the maintenance. On site maintenance sometimes is undertaken when local companies are not competent enough to undertake maintenance work or local labour costs are cheap enough to be employed in the ports. Most ports choose this strategy for most of their maintenance work, for instance, Port of Le Havre, Malta Freeport and Port of Rotterdam. The advantage of on-site maintenance with their own-resources is that it is easy to control when scheduling and planning equipment-allocation (Thomas, 1989).

Port of Felixstowe, England, is now considering contracting out all maintenance work. This action is being taken by taking into consideration the cost effect which would arise from practising this strategy (Coe, 2000, Lecture notes). This trend tends to be followed by ports in developed countries due to the expensive labour cost to employ skilled-manpower in the ports (Toubhans, 1999). Many ports now contract out specific categories of maintenance or equipment, for example, major overhauls.

There are some pressures from operations which require equipment to always be ready to operate; therefore, most ports involve maintenance staff in operation hours. Practically, the ports set up some special groups, namely an emergency maintenance group, to be involved in working a certain shift. In order to raise the awareness and participation of equipment operators to maintenance matters, the Port of Copenhagen, Denmark, employs operators from the engineering staff (Elmer, 2000, Lecture notes). This practice is quite efficient in organising preventive maintenance as well as repairs when equipment fails.

Pressure does not only come from operations, but also from port users, shipping companies for example. There is no doubt that in order to achieve economies of scale, shipping companies employ big vessels which require a high capacity of port equipment. In order to meet this requirement, the Port of Le Havre has modified its equipment, especially container gantry cranes. This is one way to improve equipment productivity without scraping or selling the existing one.

4.4 Summary

1. Although the maintenance policies which are applied to the ports are similar, there are no two or more ports that seem to follow exactly the same approach to maintenance.
2. There are various practices of maintenance strategies in the ports around the world that can be adopted to apply in a particular port. In order to find out the ideal equipment maintenance model that the port should apply, modification and models could be applied by taking into consideration the cost and benefits that the port could find favourable.

CHAPTER V
ALTERNATIVE SOLUTIONS

5.1 Introduction

No two ports actually have exactly the same system to practice maintenance policies and strategies. One port might adopt another port's system, but still there are some actions to be taken to adapt it to the ports' environment, which could be port resources, social climate, government regulations, currency etc.

In order to find out the method that the ports could apply, advantages and disadvantages of the system must be considered. Cost and benefit analysis could be made in order to measure those advantages and disadvantages. This chapter will try to find out the ideal method for equipment maintenance management which might be applied in JICT.

5.2 Maintenance Policy and Practices

Generally, there are three policy options of organising equipment maintenance, namely preventive maintenance (PM), corrective maintenance (CM) and designing-out maintenance. The implementation of these policies depends largely on the nature of maintenance itself.

Preventive maintenance (PM)

The aim of PM is to effect the work of inspection, servicing and adjustment in order to prevent equipment from failing during operation (Clifton, 1984, p.10). Basically PM is divided into two categories, i.e., systematic preventive maintenance or time-based maintenance and condition-based maintenance. Time-based maintenance is maintenance practices which are based on the calendar (yearly, monthly, weekly) or based on units representative of wear and tear (tonnes production, number of machine worked-hour, kilometres, etc.).

Among condition-based maintenance practice, there is a kind of maintenance practice which is well known by predictive maintenance (PdM). Mobley (1990, p.5) defined PdM is a maintenance practice using specific instruments, e.g., vibration monitoring, thermal imaging, lubricating oil analysis, etc., to identify whether the parts of machine need to be changed or not. The aims of PdM are to detect incipient problems and to prevent catastrophic failures.

In traditional preventive maintenance (PM), the final decision on repairs or rebuilding schedules are based on the intuition and personal experiences of the maintenance manager; therefore the PM system can only guarantee that the machine will be safe to operate, but not guarantee a cost saving. In predictive maintenance (PdM) a specific failure mode could be identified before failure; therefore, the correct repair parts, tools, labour skills and methods could be allocated to correct the problem. PdM programs could provide data on the actual mechanical condition of the machine as well. These data will enable the maintenance manager to schedule maintenance activities much more cost-effectively. For example, engine oil is changed regularly on the basis of a specific machine worked-hours or kilometres. There is no justification actually that the oil within this time period needs to be changed. But by using oil analysis for example, the maintenance manager can determine and decide when the oil must be changed.

Another example is when the maintenance manager should decide that the machine needs major repairs. By using vibration monitoring instruments and thermal imaging for example, maintenance staff could identify which parts need to be changed, so that the problem solving could focus only on those parts. Therefore, either cost or time could be saved effectively.

In order to implement this system, investment in the required instruments, e.g., vibration monitoring instrument, thermal-imaging instrument, oil analysis instrument etc. should be done. According to SKF Service AB, Sweden, (2000), to invest in an integrated vibration and electric current including oil monitoring analysis and thermography, costs US$ 50,000. To train an in-house staff specialist, costs at least US$ 5,000; therefore, US$ 55,000 is needed for the total investment. Compared to the number of engines which are owned and employed by JICT, i.e., 8 engines of container cranes, 32 of rubber-tyre gantry cranes, 71 of head trucks and 17 of diesel forklifts, the benefit of implementing this system would be significant.

The average budget that JICT allocates to contract out engine major repairs or overhaul is US$ 10,000 per-head truck's engine and US$ 15,500 per-RTGC's engine, including spare parts, service cost and tax. By organising and executing the major overhaul by itself, JICT could save money from tax and manpower costs, due to the manpower jobs being covered in their salary. Supposing that 20% of the total costs cover the service cost and 10% cover tax, this means that by organising and executing a major overhaul by itself, JICT could save US$ 3,000 for each major repair or overhaul for an HT's engine and US$ 4,650 for a RTGC's engine. By investing US$ 55,000 in purchasing the PdM's instrument, the break event point would be covered within 18 times a head truck's engine needs a major repair or overhaul, or 12 times a RTGC's engine needs a major repair or overhaul. Therefore, from the financial point of view, implementing the PdM system could benefit the management.

The consequence of implementing PdM is that all engine overhauls should be done by maintenance staff themselves in order to save money; therefore, the technical-skills of maintenance staff should be competent. In order to achieve the competitiveness of the maintenance staff, technical-skill training should be done. Another consequence is that there should be back-up engines available in order to shorten the equipment idle time.

5.3 Engineering Management Information System

One of the goals of JICT is to be a world class container terminal. There are no clear criteria actually what a world class container terminal or port means. According to the generation of ports, the latest port generation today is the third port generation. This generation was born with the development of containerisation, intermodalism and globalisation of the economy in the 1980's (Francou, 1999a, Lecture note). The third generation ports are more oriented to the supply of services to cope with the requirements of shipowners and shippers.

One of the requirements of the third generation port is that the port becomes an information centre (infostructure). In order to be that, the implementation of information technology is absolutely required. Moreover, computerised information technology is more convenient. This type of information technology is now employed by most of the major ports in Europe.

From the equipment-maintenance point of view, the engineering management information system (EMIS) should ideally be computerised. Furthermore, this computerised system should integrate the information centre, so that either shipowners or shippers could know how reliable the equipment that the port employs actually is. This is quite important for those port users due to their requirements of short time in port.

According to UNCTAD (1990, p.178), the benefits of implementing a computerised EMIS are:

1. Data could be quickly and easily stored, in as great detail as desired.
2. It is easy to be integrated to the ports' master MIS with access to operational, financial and personnel databases.
3. It could release operators, engineers and other counterparts in other departments of the time-consuming burden of analysing, summarising and circulating maintenance-derived data.

4. A computer-based data is generally available for everyone to access to, meanwhile a paper-based data system is limited to a small area. In the other side, the computer-based data system combines openness with tighter control.
5. One computer data entry could be used in a variety of contexts, serving several systems and function, meanwhile a paper-based data record must be repeated several times in order to be used in different contexts.

From these benefits, there is no doubt that by using a computerised-data system, the port could improve the efficiency of management performance.

5.4 Equipment Inventory Planning and Procurement

The joint venture company of JICT is under a Built Operate and Transfer (BOT) concession, which means that JICT is responsible to build, develop and operate the terminal for a certain period (20 years) and then to transfer it to the previous owner, that is, Indonesia Port Corporation II, Ltd. In order to improve the performance, JICT needs to invest either in new equipment or to refurbish the existing items.

In the case of purchasing new equipment, it should meet the operators' and engineers' requirements. Operationally, equipment should be reliable to operate and technically should be as close as possible to the port's technical ability to maintain. In order to meet the engineering requirement, it would be better to purchase equipment with the same manufacture as the existing ones in order to standardise the equipment inventory. The benefits of standardisation of equipment-inventory are:

1. Easy to plan and organise maintenance. By using the same equipment, the maintenance manager could easier to plan and allocate manpower to do maintenance due to their experience and sense of familiar to that equipment. The actions of overcoming the weakness of that kind of equipment will be applicable to the other one.
2. Easy to plan and procure spare parts inventory. To plan and realise the same spare parts is much easier than different ones.

3. It will be less necessary to prepare or train either maintenance or operator staff with the new technical skills, unless that equipment uses new technology. The less training needs the more savings in cost there will be.

Beside these benefits, there is likely to be the disadvantage of purchasing new equipment with the same manufacture as the existing one; that is, there will be no choice or alternatives in terms of spare parts procurement. This may lead to the bargaining power position of the supplier being higher than the buyer's position. This situation could be avoided by encouraging maintenance staff to explore their innovation skills by practising preventive maintenance, predictive maintenance and corrective maintenance. Modification is one of the outcomes of the innovation that could help to overcome this disadvantage.

5.5 Manpower and Organisational Structure

Harris (1989) in his article on Port Privatisation: A survey of global trends, in Research News, stated that one apprehension aspect regarding port privatisation comes from labour unions which are worried in losing jobs. This also applies to the manpower of JICT.

In the beginning of operation, the former workers of UTPK were employed under a contract agreement for two years which will finish on March 27, 2001 when the management of JICT has guaranteed that all of the workers would be made permanent employees (http://www.maritimindo.com/, 12 June 2000). What the JICT management should do now is to maintain the awareness and allegiance of all the staff to the company. One effort that could be made in terms of equipment maintenance staff is to give them good practical training (Vang Nielsen, 2000, lecture notes). Another advantage of giving training is to develop the skills and competence of the manpower or human resources.

There is no doubt that there will be no development of human resources without training. One advantage that JICT has now is that the management could plan and realise all the training programs without depending on IPC II anymore, due to the full autonomy of JICT to operate and manage all of the resources. This kind of autonomy was not available to the previous management.

In chapter 3, the ineffectiveness and inefficiency of the division of supervisors or engineers, which is based on the type of equipment and work area, was mentioned. There are some similarities of work in that type of equipment actually. In the case of CC and RTGC for example, the supervisors should understand either mechanically, electrically or hydraulically the equipment. This kind of requirement may lead the supervisor to not have the proper skills. In this case, the organisational structure needs to be changed in order to allow the supervisors or engineers to have the proper specific skill, mechanical or electrical skill only, so that the engineers will be more professional. Therefore, instead of six supervisors or engineers, JICT could set up three supervisors or engineers only, namely mechanical, electrical and hydraulic engineer or supervisor. The advantages of restructuring the organisation by employing three supervisors or engineers instead of six are:

- To cut labour cost.
- To simplify co-ordination and supervision.
- To make the supervisor or engineers more of a specialist; furthermore, to be more professional.

The disadvantage of setting up supervisors or engineers not based on the job's location is that those engineers or supervisors will have a high mobility in order to cover the jobs in both locations. This is necessary since the location of the both terminals are quite far apart (see appendix A).

5.6 Summary

Although in general the achievement of the JICT management in terms of container handling equipment performance is improving, there are still some actions which could be taken in order to more improve performance. Introducing predictive maintenance as well as preventive and corrective maintenance is one action that could be applied. Implementation of the computerised engineering management information system that could be integrated to other information systems, standardising equipment by acquiring the same equipment as that existing and maintaining the awareness and allegiance of staff are other efforts that could be made. The restructuring of organisational also needs to be acted upon in order to attain higher professionalism and specialisation skills of the engineers in a particular field, namely mechanical, electrical and hydraulic.

CHAPTER VI
CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

Unit Terminal Petikemas Tanjung Priok (UTPK Tanjung Priok), the embryo of Jakarta International Container Terminal (JICT), was the largest existing container terminal in Indonesia. The terminal was a daughter company of Indonesia Port Corporation II, Limited (IPC II Ltd.), a State-owned company, and was affected very largely by government regulations in its operation. The consequence of these regulations, especially relating to the procurement procedure, had a great negative impact on the performance of container handling equipment. A long procedure for equipment spare parts procurement was the biggest reason for the lack of spare parts available which lead to low equipment availability at any moment. The economic crisis, which led to an increase in local currency appreciation of foreign currencies, was another reason for the lack of spare parts availability. Equipment spare-part prices, which are mostly affected by foreign currency rates, were becoming sky high so that they were unreachable according to budget set up.

In this situation, the terminal was privatised in order to strengthen its capital structure. The new privatised container terminal was named Jakarta International Container Terminal (JICT) and established by IPC II, Ltd. as the previous parent company and Hutchison Port Holding (HPH) Hongkong as the new investors. HPH, which owns 51% of the shares, then took more initiative, either managerially or operationally, in order to improve the company's performance. The change of organisational structure was one of the actions. Engineering was set up to be a sub-department of operations in order to simplify the co-ordination between engineer and maintenance staff on the one hand, and operation supervisor and operator on the other hand. This kind of co-ordination was significant in planning and organising equipment maintenance.

Another change which was taken by the new management was to change measuring equipment performance indicators, which more oriented to the operational achievement rather than others. Instead of measuring mean time between failures (MTBF), which is traditionally used by UTPK and other ports around the world, JICT uses mean movement between failures (MMBF) as one equipment performance indicator. By measuring the number of containers that could be moved in between two failures, the reliability of equipment could be measured as objectively as possible.

As a private company, JICT operates the terminals without very largely depending on the government regulations, especially for procurement procedures. By short-cutting the procedure the availability of equipment spare parts could be guaranteed. Furthermore, the availability of equipment could be improved. Moreover, the practice of selling and buying used engines to replace new ones or overhauled ones seems to significantly contribute to the improvement of these performances. The selling and buying method could effectively shorten equipment idle time, so that the availability of equipment could be improved.

6.2 Recommendations

Although there are some improvements that can be achieved by the new management related to equipment performance, there are some efforts that could be made other than the practising ones in order to achieve the ideal model of maintenance management. The method could not be adopted directly from other port systems, but needs to be adapted within JICT's environment.

In order to further improve the performance of container handling equipment in JICT, there are some recommendations which might be made concerning management, related to maintenance management and organisation.

6.2.1 Short-term period

In the short-term period, that is less than one year, it is recommended that the management apply predictive maintenance (PdM) as well as preventive and corrective maintenance due to the financial advantages. By looking at the large number of equipment in the JICT inventory, investment for PdM's instrument requirement seems to be more useful in achieving a more effective maintenance cost and time.

Improvement of technical-skill training for the equipment maintenance staff needs to be made in the short-term period as well, in order to cover the implementation of PdM system.

6.2.2 Medium-term periods

In the medium-term period, that is between one to five years, it is recommended that the management restructure the organisation in order to improve the professionalism of the staff. Instead of setting up supervisors or engineers based on the type of equipment and work area, it is recommended to change the field of work, namely to mechanical, electrical and hydraulic engineers or supervisors. More technical training programs for maintenance staff is another action which should be taken in order to maintain and more motivate the allegiance of the staff to the company.

Implementation of a computerised-engineering management information system which could be linked to the master of other management information systems, namely operation management information system, finance management information system and personnel management information system, needs to be speeded up. This kind of implementation would make it easier to plan, control and evaluate the implementation of maintenance programs. Another advantage of this practice is to speed up the achievement of the company's objective, that is to be a world class container terminal which is identical with the information technology centre (infostructure).

6.2.3 Long-term period

In the long-term period, that is more than five years, the standardisation of equipment to be employed needs to be acted upon. Replacement of the old equipment with the new should refer to the manufacture of the equipment-population which has been employed. This action will make it easier to plan maintenance and spare part inventory requirements. Retrofitting which would be acted upon should also refer to the systems and technologies which are employed by the terminals and be familiar to the maintenance staff.

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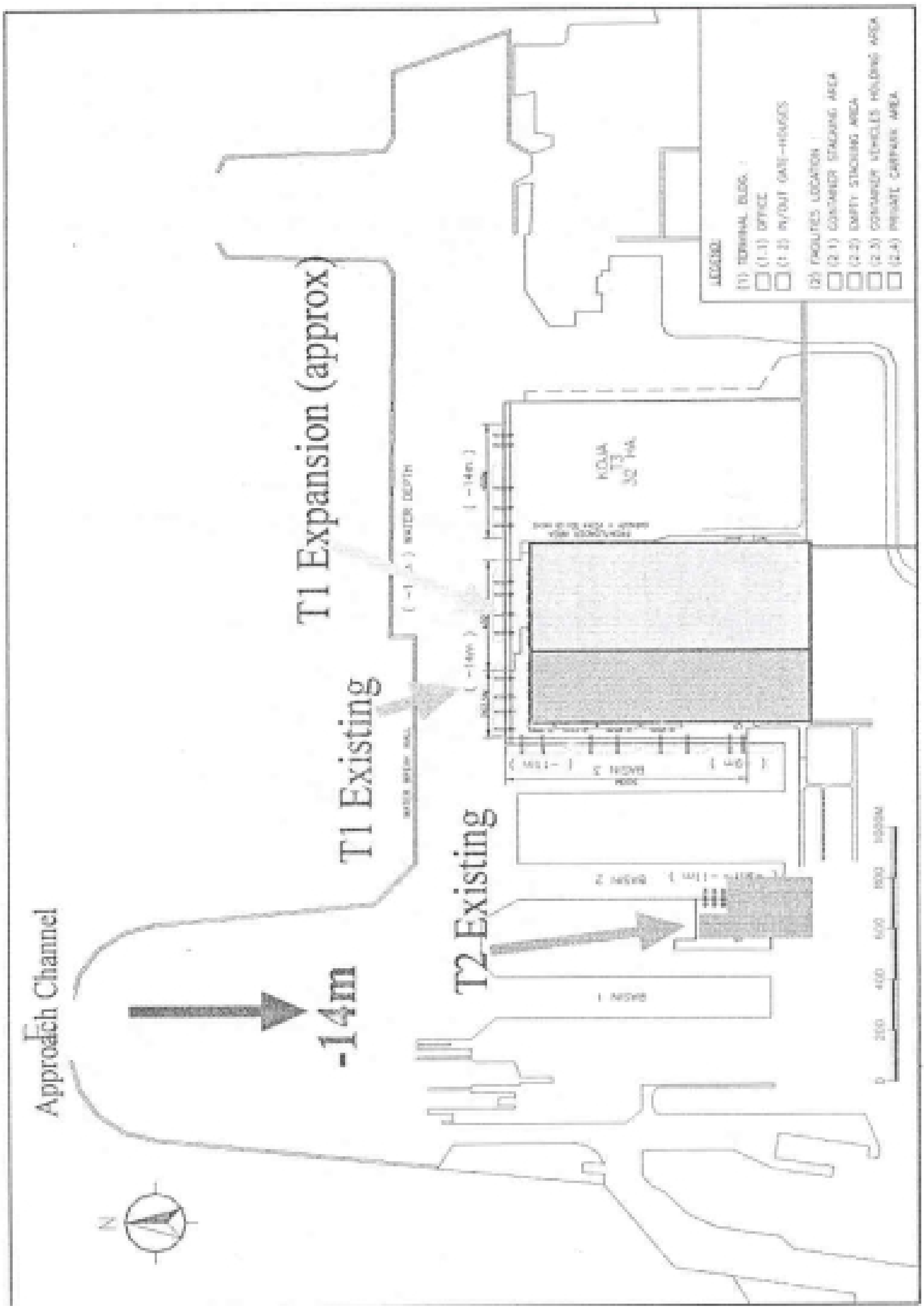
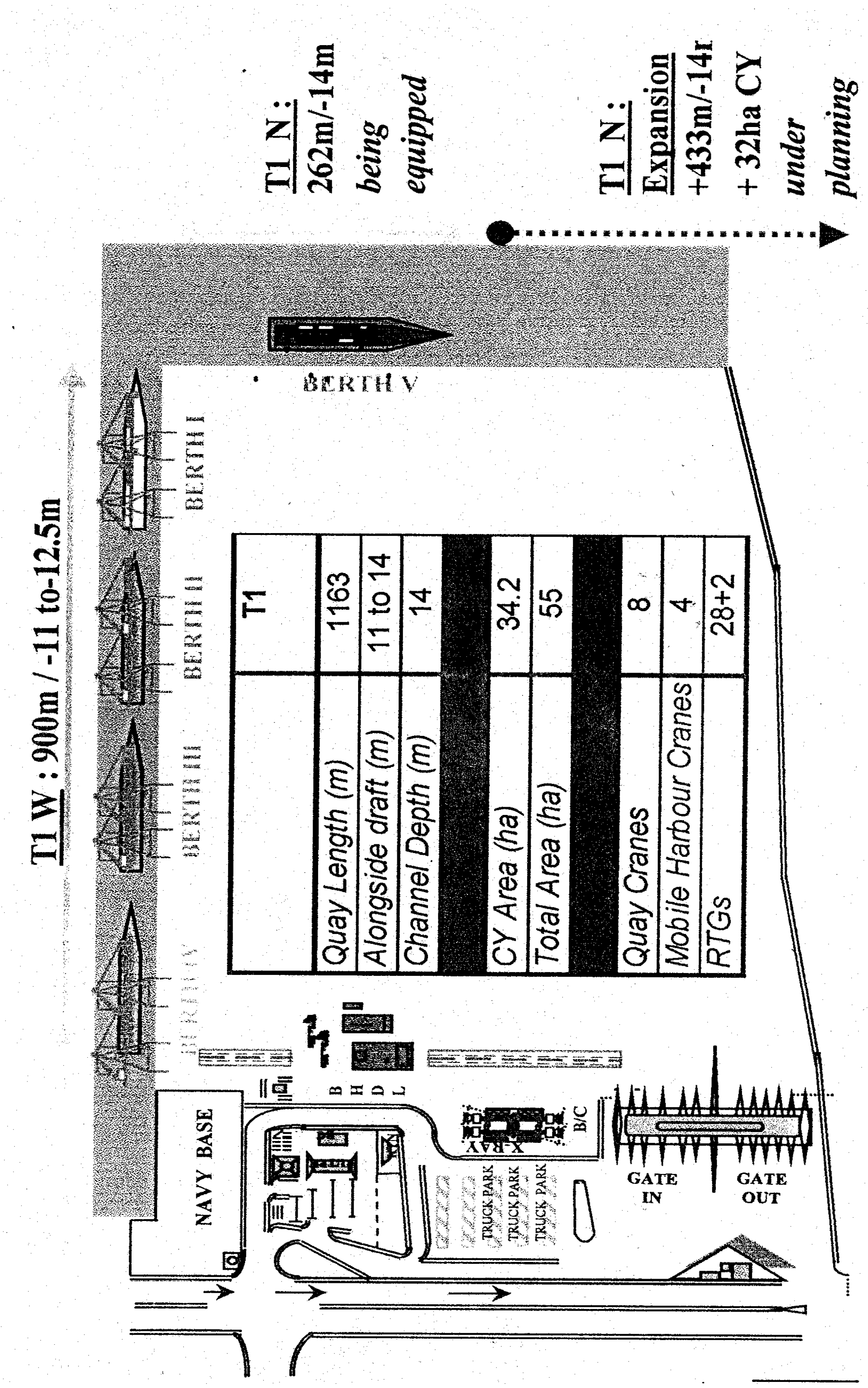
Appendix A

The Location of JICT



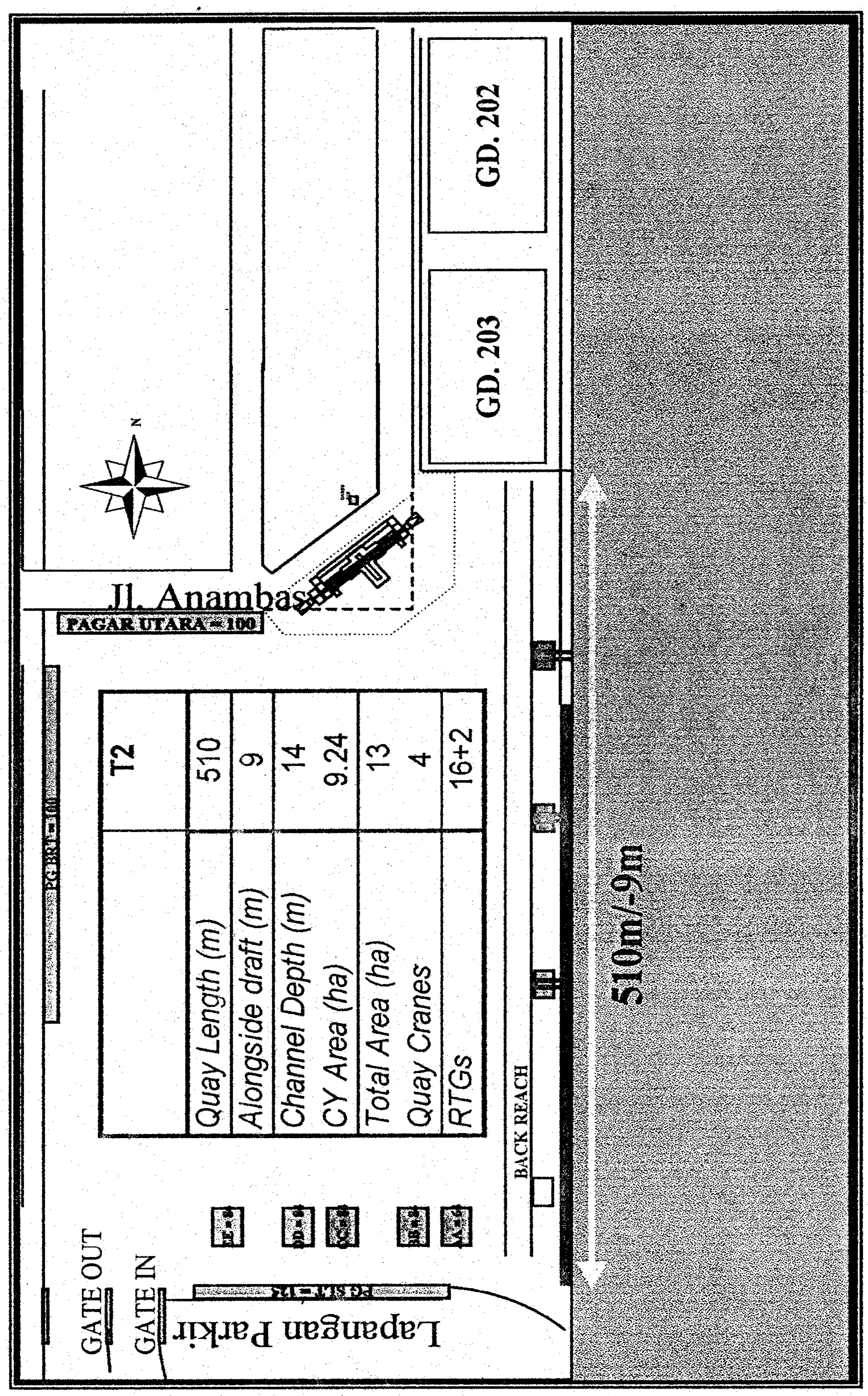
Appendix B

The Layout of Terminal I



Appendix C

The Layout of Terminal II



	T2
Quay Length (m)	510
Alongside draft (m)	9
Channel Depth (m)	14
CY Area (ha)	9.24
Total Area (ha)	13
Quay Cranes	4
RTGs	16+2

Appendix D
Fault Code List

System	Device	
A (AUX-EQT)	A0	M-house facilities
	A1	Air condition
	A2	Lights
	A3	Control cab. Fitting
	A4	Automation component
	A5	Checker Office
	A6	Air compressor
	A7	Ventilation
B (Boom)	B0	Boom hoist/boom
	B1	Boom hoist/hoisting
	B2	Boom hoist/lowering
	B3	Boom latch
C (Communication)	C0	Communication (radio)
	C1	Communication (intercom)
	C2	Main public address
E (Engine)	E0	Main engine
	E1	Aux engine
	E2	Starter
P (Power Source)	P1	Substation / Battery charging
	P2	HF Cable
	P3	Cable pit / Cable restrainer
	P4	HI Panel
	P5	MG Set / Main generator
	P6	LV supply / control source
	P7	... source
S (Spreader Lift beam Lifting Gear)	S0	Spreader
	S1	Twistlock
	S2	Flipper
	S3	Telescopic
	S4	Landing
	S5	Other lifting gear
T (Trolley Travel)	T0	Trolley travel
	T1	Trolley travel (forward)
	T2	Trolley travel (backward)
	T3	Festoon cable
	T4	Rope tensioner
G (Gantry Travel)	G0	Gantry travel
	G1	Wind speed detection
	G2	Cable reel / steering / turning
	G3	Rail clamp / Anchor pin / Wheel locking / The down Gear
	G4	Warning device
H (Main Hoist)	H0	Main hoist
	H1	Main hoist (hoisting)
	H2	Main hoist (lowering)
	H3	Head Block
	H4	Antisway / sheave shuttle
	H5	Separate trolley
	H6	Stavie
	H7	Trim / List / Skew
	H8	Baloney cable
X (Others)	X0	Machine down time by operation request for investigation
	X1	Machine down time due to collision, falling object or accident

	System Failure Code	Example
1	Mechanical Drive/Locking System	Brake, chain, gear, linkage, twistlock, Pin, rod, shaft, dll
2	Carrier/Rolling System	Brake, carrier, rail, roller, tire, wheel, dll
3	Wire Rope/ Sheave system	Wire rope (Working/ Suspecsion) sheave, guide, roller, rope clam, dll
4	Mechanical Control Sys.	Accel/Brake, shaft lever, control level steering wheel, regulator, indicator, dll
5	Hydraulic System	Actuator, hose, piping, pump, valve, manifold, oil tank, pressure gauge
6	Electrical Drive/ Power System	Battery, HT Cable. Power Circuit. Generator, Motor Brake, Thrustor, dll
7	Detection/ Sensing Sys.	Limit Switch Load/Speed Sensor, pressure switch, Activator, striker, rope, slack
8	Electric/ Electronic/ Control Sys.	Master controller, control relay, control circuit, indicator, control switch, control card, dll
9	Structural System	Truck, equalizer, leg, boom, mast, bumper, guard, ladder, frame, rail, rail mounting, cab, dll
0	Fuel/Lub/Cooling System	Piping, radiator, fan, pump, coolant, fuel, lubricant, tank, etc,
Y	System Outside of Machine	Substation Gear, Cable Pit, Runway, Gantry rail, Cable Trough, Ship gear, Other Machines

	Failure Type	Example
1	Adjustment/ Calibration	Limit switch speed/ Voltage/Current setting / Pressure setting brake air gap / Torque, dll
2	Dislocation / Loosened	Cable, wiring, rope, hose, hose joint, bolt, mounting, fastening, dll
3	Damage / Deformation	Elec/Mech Parts Device structural, dll
4	Jamming	Elec/Mech moving Parts
5	Broken	Elec/Mech Parts, device, wire rope, structure, bolt, dll
6	Ageing/ Work-Out	Light bulb, ballast, wire rope, solenoid motor, generator, resistor, radiator, air-con, dll
7	Fluid Leakage	Hydraulic Oil, Lug Oil Water coolant, Fuel
8	Burnt/Overheat/ Frozen	Fuse/Relay/Contactor/ Brake Coil, Solenoid motor, generator, resistor, radiator, air-con, dll
9	Short/Open Circuit Malfunction	Control Circuit, Electronic Device
0	Out of Control of Machine	Misoperation, Abuse, Accident, Operation, Requested Investigation
Z	Cause Under Investigation	No Fault was found, Before arrival resumed

JOB CLASS	
C5	Break down ≤ 0,5 hour
C4	Break down ≤ 1 hour
C3	Break down ≤ 2 hour
C2	Break down > 2 hour
C1	Collision / Accident
OP	Mis-Operation by operator

Example.

S2Y3	Deformed Container Twistlock
S3Y3	Deformed Container Flipper
S5Y3	Deformed Container Landing

FAULTCODE LIST

Appendix E

The Age and Conditions of Equipment in JICT

No.	Equipment Type	Register Number	Capacity (tons)	Manufacturer		Year		Engine		Remarks
				Mark	Country	Made	Used	Mark	HP	
CONTAINER CRANE (CC)										
1	CC	CC.01	35.5	Sumitomo	Japan	1983	1983	Caterpillar	830	Retrofit 98
2	CC	CC.02	50	Sumitomo	Japan	1976	1978	Caterpillar	830	Retrofit 98
3	CC	CC.03	50	Sumitomo	Japan	1976	1978	Caterpillar	830	Retrofit 97
4	CC	CC.04	40	Noell	Germany	1992	1992	Caterpillar	1379	
5	CC	CC.05	40	Noell	Germany	1992	1992	Caterpillar	1379	Retrofit 97
6	CC	CC.06	40	Noell	Germany	1992	1992	Caterpillar	1379	Retrofit 97
7	CC	CC.07	35	Guna Nusa	Indonesia	1997	1997	Caterpillar	2095	
8	CC	CC.08	35	Guna Nusa	Indonesia	1997	1997	Caterpillar	2095	
9	CC	CC.02A	30.5	Mitsui	Japan	1972	1991	-	-	
Rubber-Tyre Gantry Crane (RTGC)										
1	RTGC	TT.03	35	Hitachi	Japan	1983	1983	Caterpillar	400	Retrofit 97
2	RTGC	TT.04	35	Hitachi	Japan	1983	1983	Caterpillar	400	Retrofit 97
3	RTGC	TT.05	35	Hitachi	Japan	1983	1983	Caterpillar	400	Retrofit 97
4	RTGC	TT.16	35	Hyundai	Korea	1989	1990	Caterpillar	540	Retrofit 96
5	RTGC	TT.17	35	Hyundai	Korea	1989	1990	Caterpillar	540	Retrofit 97
6	RTGC	TT.18	35	Hyundai	Korea	1990	1990	Caterpillar	540	Retrofit 97
7	RTGC	TT.20	35	Mitsui	Japan	1991	1991	Caterpillar	400	
8	RTGC	TT.21	35	Mitsui	Japan	1991	1991	Caterpillar	400	
9	RTGC	TT.22	35	Mitsui	Japan	1991	1991	Caterpillar	400	
10	RTGC	TT.23	35	Mitsui	Japan	1991	1991	Caterpillar	400	
11	RTGC	TT.24	35	Mitsui	Japan	1991	1991	Caterpillar	400	
12	RTGC	TT.25	35	Mitsui	Japan	1991	1991	Caterpillar	400	
13	RTGC	TT.26	35	Mitsui	Japan	1991	1991	Caterpillar	400	
14	RTGC	TT.27	35	Mitsui	Japan	1991	1991	Caterpillar	400	
15	RTGC	TT.28	35	Mitsui	Japan	1991	1991	Caterpillar	400	
16	RTGC	TT.29	35	Mitsui	Japan	1991	1991	Caterpillar	400	
17	RTGC	TT.30	35	Mitsui	Japan	1991	1991	Caterpillar	400	
18	RTGC	TT.31	35	Mitsui	Japan	1991	1991	Caterpillar	400	
19	RTGC	TT.32	35	Mitsui	Japan	1991	1991	Caterpillar	400	
20	RTGC	TT.33	35	Mitsui	Japan	1991	1991	Caterpillar	400	
21	RTGC	TT.34	35	Mitsui	Japan	1991	1991	Caterpillar	400	
22	RTGC	TT.01A	30,5	Paceco	USA	1979	1991	Detroit	175	Retrofit 95
23	RTGC	TT.02A	30,5	Paceco	USA	1979	1991	Cummins	175	Retrofit 96
24	RTGC	TT.03A	30,5	Paceco	USA	1979	1991	Detroit	175	
25	RTGC	TT.04A	30,5	Paceco	USA	1979	1991	Detroit	175	
26	RTGC	TT.05A	30,5	Paceco	USA	1976	1992	Cummins	175	Retrofit 96
27	RTGC	TT.06A	30,5	Paceco	USA	1979	1992	Detroit	175	
28	RTGC	TT.07A	30,5	Paceco	USA	1979	1992	Detroit	175	
29	RTGC	TT.08A	30,5	Hyundai	Korea	1988	1988	Caterpillar	540	Retrofit 96
30	RTGC	TT.09A	30,5	Hyundai	Korea	1988	1988	Caterpillar	540	Retrofit 96
31	RTGC	TT.10A	30,5	Hyundai	Korea	1988	1988	Caterpillar	540	Retrofit 96
32	RTGC	TT.11A	35	Hyundai	Korea	1990	1988	Caterpillar	540	Retrofit 97

Appendix E (Cont'd)

The Age and Conditions of Equipment in JICT

No.	Equipment Type	Register Number	Capacity (tons)	Manufacturer		Year		Engine		Remarks
				Mark	Country	Made	Used	Mark	HP	
FORKLIFT-DIESEL (FD)										
1	FD	FD.01	42	Fantuzzi	Italy	1996	1997	Volvo		
2	FD	FD. 02	36	TCM	Japan	1983	1985	Isuzu	-	
3	FD	FD. 04	25	Mitsubishi	Japan	1979	1979	Mitsubishi	-	
4	FD	FD.08	15	Fantuzzi	Italy	1996	1997	Volvo	-	
5	FD	FD.09	15	Fantuzzi	Italy	1996	1997	Volvo	-	
6	FD	FD. 16	2	Datsun	Japan	1983	1984	Datsun	-	
7	FD	FD. 18	2	Datsun	Japan	1983	1984	Datsun	-	
8	FD	FD. 19	2	Datsun	Japan	1983	1984	Datsun	-	
9	FD	FD 20	3,5	Komatsu	Japan	1996	1997	Komatsu	64	
10	FD	FD. 29	2	Nissan	Japan	1991	1991	Nissan	-	
11	FD	FD. 03A	2	Nissan	Japan	1991	1991	Nissan	-	
12	FD	FD. 04A	42	Fantuzzi	Italy	1996	1996	Volvo	-	
13	FD	FD. 05A	15	Fantuzzi	Italy	1996	1996	Volvo	-	
14	FD	FD.08A	2	Nissan	Japan	1991	1991	Nissan	-	
15	FD	FD.09A	2	Datsun	Japan	1983	1984	Datsun	-	
16	FD	FD. 11A	10	TCM	Japan	1983	1983	Isuzu	-	
17	FD	FD.16A	36	TCM	Japan	1983	1983	Isuzu	-	
HEAD TRUCK (HT)										
1	HT	HT. 23	40	Ottawa	Canada	1988	1988	Caterpillar	175	
2	HT	HT. 25	40	Ottawa	Canada	1988	1988	Caterpillar	175	
3	HT	HT. 26	40	Ottawa	Canada	1988	1988	Caterpillar	175	
4	HT	HT. 28	40	Ottawa	Canada	1988	1988	Caterpillar	175	
5	HT	HT. 29	40	Ottawa	Canada	1988	1988	Caterpillar	175	
6	HT	HT. 30	40	Ottawa	Canada	1988	1988	Caterpillar	175	
7	HT	HT. 31	40	Ottawa	Canada	1988	1988	Caterpillar	175	
8	HT	HT. 32	40	Ottawa	Canada	1988	1988	Caterpillar	175	
9	HT	HT. 33	40	Ottawa	Canada	1988	1988	Caterpillar	175	
10	HT	HT. 34	40	Ottawa	Canada	1988	1988	Caterpillar	175	
11	HT	HT. 35	40	Ottawa	Canada	1988	1988	Caterpillar	175	
12	HT	HT. 36	40	Ottawa	Canada	1988	1988	Caterpillar	175	
13	HT	HT. 37	40	Ottawa	Canada	1988	1988	Caterpillar	175	
14	HT	HT. 38	40	Ottawa	Canada	1991	1991	Caterpillar	175	
15	HT	HT. 40	40	Ottawa	Canada	1991	1991	Caterpillar	175	
16	HT	HT. 41	40	Ottawa	Canada	1991	1991	Caterpillar	175	
17	HT	HT. 42	40	Ottawa	Canada	1991	1991	Caterpillar	175	
18	HT	HT. 43	40	Ottawa	Canada	1991	1991	Caterpillar	175	
19	HT	HT. 44	40	Ottawa	Canada	1991	1991	Caterpillar	175	
20	HT	HT. 45	40	Ottawa	Canada	1991	1991	Caterpillar	175	
21	HT	HT. 46	40	Ottawa	Canada	1991	1991	Caterpillar	175	
22	HT	HT. 47	40	Ottawa	Canada	1991	1991	Caterpillar	175	
23	HT	HT. 48	40	Ottawa	Canada	1991	1991	Caterpillar	175	
24	HT	HT. 49	40	Ottawa	Canada	1991	1991	Caterpillar	175	
25	HT	HT. 50	40	Ottawa	Canada	1991	1991	Caterpillar	175	
26	HT	HT. 51	40	Ottawa	Canada	1991	1991	Caterpillar	175	
27	HT	HT. 52	40	Ottawa	Canada	1991	1991	Caterpillar	175	
28	HT	HT. 53	40	Ottawa	Canada	1991	1991	Caterpillar	175	
29	HT	HT. 55	40	Ottawa	Canada	1991	1991	Caterpillar	175	
30	HT	HT. 56	40	Ottawa	Canada	1991	1991	Caterpillar	175	
31	HT	HT. 57	40	Ottawa	Canada	1991	1991	Caterpillar	175	
32	HT	HT. 58	40	Capacity	USA	1995	1995	Caterpillar	210	
33	HT	HT. 59	40	Capacity	USA	1995	1995	Caterpillar	210	
34	HT	HT. 60	40	Capacity	USA	1995	1995	Caterpillar	210	
35	HT	HT. 61	40	Capacity	USA	1995	1995	Caterpillar	210	
36	HT	HT. 62	40	Capacity	USA	1995	1995	Caterpillar	210	
37	HT	HT. 63	40	Capacity	USA	1995	1995	Caterpillar	210	

Appendix E (Cont'd)

The Age and Conditions of Equipment in JICT

No.	Equipment Type	Register Number	Capacity (tons)	Manufacturer		Year		Engine		Remarks
				Mark	Country	Made	Used	Mark	HP	
HEAD TRUCK (Cont'd)										
38	HT	HT. 64	40	Capacity	USA	1995	1995	Caterpillar	210	
39	HT	HT. 65	40	Capacity	USA	1995	1995	Caterpillar	210	
40	HT	HT. 66	40	Capacity	USA	1995	1995	Caterpillar	210	
41	HT	HT. 67	40	Capacity	USA	1995	1995	Caterpillar	210	
42	HT	HT. 68	40	Capacity	USA	1995	1995	Caterpillar	210	
43	HT	HT. 69	40	Capacity	USA	1995	1995	Caterpillar	210	
44	HT	HT. 70	40	Capacity	USA	1995	1995	Caterpillar	210	
45	HT	HT. 71	40	Capacity	USA	1995	1995	Caterpillar	210	
46	HT	HT. 72	40	Capacity	USA	1995	1995	Caterpillar	210	
47	HT	HT. 73	40	Capacity	USA	1995	1995	Caterpillar	210	
48	HT	HT. 74	40	Capacity	USA	1995	1995	Caterpillar	210	
49	HT	HT. 75	40	Capacity	USA	1995	1995	Caterpillar	210	
50	HT	HT. 76	40	Capacity	USA	1995	1995	Caterpillar	210	
51	HT	HT. 77	40	Capacity	USA	1995	1995	Caterpillar	210	
52	HT	HT. 78	40	Ottawa	Canada	1996	1996	Caterpillar	210	
53	HT	HT. 79	40	Ottawa	Canada	1996	1996	Caterpillar	210	
54	HT	HT. 80	40	Ottawa	Canada	1996	1996	Caterpillar	210	
55	HT	HT. 81	40	Ottawa	Canada	1996	1996	Caterpillar	210	
56	HT	HT. 82	40	Ottawa	Canada	1996	1996	Caterpillar	210	
57	HT	HT.01A.	40	Ottawa	Canada	1991	1991	Caterpillar	175	
58	HT	HT.02A.	40	Ottawa	Canada	1991	1991	Caterpillar	175	
59	HT	HT.03A.	40	Ottawa	Canada	1991	1991	Caterpillar	175	
60	HT	HT.04A.	40	Ottawa	Canada	1991	1991	Caterpillar	175	
61	HT	HT.05A.	40	Ottawa	Canada	1991	1991	Caterpillar	175	
62	HT	HT.06A.	40	Ottawa	Canada	1991	1991	Caterpillar	175	
63	HT	HT.07A.	40	Ottawa	Canada	1991	1991	Caterpillar	175	
64	HT	HT.08A.	40	Ottawa	Canada	1991	1991	Caterpillar	175	
65	HT	HT.09A.	40	Ottawa	Canada	1991	1991	Caterpillar	175	
66	HT	HT.010A.	40	Ottawa	Canada	1991	1991	Caterpillar	175	
67	HT	HT.011A.	40	Ottawa	Canada	1996	1996	Caterpillar	210	
68	HT	HT.012A.	40	Ottawa	Canada	1996	1996	Caterpillar	210	
69	HT	HT.013A.	40	Ottawa	Canada	1996	1996	Caterpillar	210	
70	HT	HT.014A.	40	Ottawa	Canada	1996	1996	Caterpillar	210	
71	HT	HT.015A.	40	Ottawa	Canada	1996	1996	Caterpillar	210	
C H A S S I S (CHS)										
1	CHS	CHS. 01	40	Hargill-Co	Canada	1978	1978	-	-	
2	CHS	CHS. 03	40	Hargill-Co	Canada	1978	1978	-	-	
3	CHS	CHS. 04	40	Hargill-Co	Canada	1978	1978	-	-	
4	CHS	CHS. 05	40	Hargill-Co	Canada	1978	1978	-	-	
5	CHS	CHS. 06	40	Hargill-Co	Canada	1978	1978	-	-	
6	CHS	CHS. 07	40	Hargill-Co	Canada	1978	1978	-	-	
7	CHS	CHS. 10	40	Hargill-Co	Canada	1978	1978	-	-	
8	CHS	CHS. 11	40	Hargill-Co	Canada	1978	1978	-	-	
9	CHS	CHS. 12	40	Hargill-Co	Canada	1978	1978	-	-	
10	CHS	CHS. 13	40	Hargill-Co	Canada	1978	1978	-	-	
11	CHS	CHS. 14	40	Hargill-Co	Canada	1978	1978	-	-	
12	CHS	CHS. 15	40	Hargill-Co	Canada	1978	1978	-	-	
15	CHS	CHS. 17	40	PT. Bukaka	Indonesia	1983	1983	-	-	
13	CHS	CHS. 24	40	Hargill-Co	Canada	1978	1978	-	-	
14	CHS	CHS. 29	40	Hargill-Co	Canada	1978	1978	-	-	
16	CHS	CHS. 25	40	PT. Bukaka	Indonesia	1983	1983	-	-	
17	CHS	CHS. 27	40	PT. Bukaka	Indonesia	1983	1983	-	-	
18	CHS	CHS. 30	40	PT. Bukaka	Indonesia	1983	1983	-	-	
19	CHS	CHS. 34	40	PT. Bukaka	Indonesia	1983	1983	-	-	

Appendix E (Cont'd)

The Age and Conditions of Equipment in JICT

No.	Equipment Type	Register Number	Capacity (tons)	Manufacturer		Year		Engine		Remarks
				Mark	Country	Made	Used	Mark	HP	
CHASSIS (Cont'd)										
20	CHS	CHS. 48	40	Mandiri	Indonesia	1988	1988	-	-	
21	CHS	CHS. 49	40	Mandiri	Indonesia	1988	1988	-	-	
22	CHS	CHS. 50	40	Mandiri	Indonesia	1988	1988	-	-	
23	CHS	CHS. 51	40	Mandiri	Indonesia	1988	1988	-	-	
24	CHS	CHS. 52	40	Mandiri	Indonesia	1988	1988	-	-	
25	CHS	CHS. 54	40	Mandiri	Indonesia	1988	1988	-	-	
26	CHS	CHS. 55	40	Mandiri	Indonesia	1988	1988	-	-	
27	CHS	CHS. 56	40	Mandiri	Indonesia	1988	1988	-	-	
28	CHS	CHS. 57	40	Mandiri	Indonesia	1988	1988	-	-	
29	CHS	CHS. 58	40	Mandiri	Indonesia	1988	1988	-	-	
30	CHS	CHS. 59	40	Mandiri	Indonesia	1988	1988	-	-	
31	CHS	CHS. 61	40	Mandiri	Indonesia	1988	1988	-	-	
32	CHS	CHS. 62	40	Mandiri	Indonesia	1988	1988	-	-	
33	CHS	CHS. 64	40	PT. Gemala	Indonesia	1991	1991	-	-	
34	CHS	CHS. 65	40	PT. Gemala	Indonesia	1991	1991	-	-	
35	CHS	CHS. 66	40	PT. Gemala	Indonesia	1991	1991	-	-	
36	CHS	CHS. 67	40	PT. Gemala	Indonesia	1991	1991	-	-	
37	CHS	CHS. 68	40	PT. Gemala	Indonesia	1991	1991	-	-	
38	CHS	CHS. 69	40	PT. Gemala	Indonesia	1991	1991	-	-	
39	CHS	CHS. 70	40	PT. Gemala	Indonesia	1991	1991	-	-	
40	CHS	CHS. 72	40	PT. Gemala	Indonesia	1991	1991	-	-	
41	CHS	CHS. 73	40	PT. Gemala	Indonesia	1991	1991	-	-	
42	CHS	CHS. 74	40	PT. Gemala	Indonesia	1991	1991	-	-	
43	CHS	CHS. 76	40	PT. Gemala	Indonesia	1991	1991	-	-	
44	CHS	CHS. 77	40	PT. Gemala	Indonesia	1991	1991	-	-	
45	CHS	CHS. 78	40	PT. Gemala	Indonesia	1991	1991	-	-	
46	CHS	CHS. 79	40	PT. Gemala	Indonesia	1991	1991	-	-	
47	CHS	CHS. 80	40	PT. Gemala	Indonesia	1991	1991	-	-	
48	CHS	CHS. 81	40	PT. Gemala	Indonesia	1991	1991	-	-	
49	CHS	CHS. 82	40	PT. Gemala	Indonesia	1991	1991	-	-	
50	CHS	CHS. 83	40	PT. Gemala	Indonesia	1991	1991	-	-	
51	CHS	CHS. 84	40	PT. Gemala	Indonesia	1991	1991	-	-	
52	CHS	CHS. 85	40	PT. Gemala	Indonesia	1991	1991	-	-	
53	CHS	CHS. 86	40	PT. Gemala	Indonesia	1991	1991	-	-	
54	CHS	CHS. 87	40	PT. Gemala	Indonesia	1991	1991	-	-	
55	CHS	CHS. 88	40	PT. Gemala	Indonesia	1991	1991	-	-	
56	CHS	CHS. 89	40	PT. Gemala	Indonesia	1991	1991	-	-	
57	CHS	CHS. 90	40	PT. Gemala	Indonesia	1991	1991	-	-	
58	CHS	CHS. 91	40	PT. Gemala	Indonesia	1991	1991	-	-	
59	CHS	CHS. 92	40	PT. Gemala	Indonesia	1991	1991	-	-	
60	CHS	CHS. 93	40	PT. Gemala	Indonesia	1991	1991	-	-	
61	CHS	CHS. 01A	40	PT. Gemala	Indonesia	1991	1991	-	-	
62	CHS	CHS. 02A	40	PT. Gemala	Indonesia	1991	1991	-	-	
63	CHS	CHS. 03A	40	PT. Gemala	Indonesia	1991	1991	-	-	
64	CHS	CHS. 04A	40	PT. Gemala	Indonesia	1991	1991	-	-	
65	CHS	CHS. 04A	40	PT. Gemala	Indonesia	1991	1991	-	-	
66	CHS	CHS. 05A	40	PT. Gemala	Indonesia	1991	1991	-	-	
67	CHS	CHS. 06A	40	PT. Gemala	Indonesia	1991	1991	-	-	
68	CHS	CHS. 07A	40	PT. Gemala	Indonesia	1991	1991	-	-	
69	CHS	CHS. 08A	40	PT. Gemala	Indonesia	1991	1991	-	-	
70	CHS	CHS. 09A	40	PT. Gemala	Indonesia	1991	1991	-	-	
71	CHS	CHS. 10A	40	PT. Gemala	Indonesia	1991	1991	-	-	
72	CHS	CHS. 11A	40	PT. Gemala	Indonesia	1991	1991	-	-	
73	CHS	CHS. 11A	40	PT. Gemala	Indonesia	1991	1991	-	-	
74	CHS	CHS. 12A	40	PT. Gemala	Indonesia	1991	1991	-	-	

Appendix E (Cont'd)

The Age and Conditions of Equipment in JICT

No.	Equipment Type	Register Number	Capacity (tons)	Manufacturer		Year		Engine		Remarks
				Mark	Country	Made	Used	Mark	HP	
C H A S S I S (Cont'd)										
75	CHS	CHS. 13A	40	PT. Gemala	Indonesia	1991	1991	-	-	
76	CHS	CHS. 13A	40	PT. Gemala	Indonesia	1991	1991	-	-	
77	CHS	CHS. 14A	40	PT. Gemala	Indonesia	1991	1991	-	-	
78	CHS	CHS. 15A	40	PT. Gemala	Indonesia	1991	1991	-	-	
79	CHS	CHS. 16A	40	PT. Gemala	Indonesia	1991	1991	-	-	
80	CHS	CHS. 17A	40	PT. Gemala	Indonesia	1991	1991	-	-	
81	CHS	CHS. 18A	40	PT. Gemala	Indonesia	1991	1991	-	-	
82	CHS	CHS. 19A	40	PT. Gemala	Indonesia	1991	1991	-	-	
83	CHS	CHS. 20A	40	Mandiri	Indonesia	1997	1997	-	-	
84	CHS	CHS. 21A	40	Mandiri	Indonesia	1997	1997	-	-	
85	CHS	CHS. 22A	40	Mandiri	Indonesia	1997	1997	-	-	
86	CHS	CHS. 23A	40	Mandiri	Indonesia	1997	1997	-	-	
87	CHS	CHS. 24A	40	Mandiri	Indonesia	1997	1997	-	-	
88	CHS	CHS. 25A	40	Mandiri	Indonesia	1997	1997	-	-	
89	CHS	CHS. 26A	40	Mandiri	Indonesia	1997	1997	-	-	
90	CHS	CHS. 27A	40	Mandiri	Indonesia	1997	1997	-	-	
91	CHS	CHS. 28A	40	Mandiri	Indonesia	1997	1997	-	-	
92	CHS	CHS. 29A	40	Mandiri	Indonesia	1997	1997	-	-	

Source: Company record.