6 CONCLUSION AND RECOMMENDATIONS

6.1 Summary

Chapter 1 was devoted to an introduction to the Port of Colombo, its development, containerization and the research undertaken. It discussed the importance of the research and how the use of ICT systems in cargo handling equipment can also be a factor in attracting business. The general objective of this research was to assess the use, adoption, benefits and impact of information and communication technologies for cargo handling equipment in ports. To accomplish the objectives, secondary and primary data and information were used. It also discussed the methods of getting the data and information and limitations of getting data and information for the study.

Chapter 2 discussed the operation management of the container terminal as well as the different types of container handling equipment with details of their main functions. This chapter also discussed the operations of the world-leading terminal /port operators and the leading cargo handling equipment manufacturers, their market share and the trend of ordering new equipment for container handling.

Chapter 3 discussed the literature reviewed. It focused on the container shipping industry from its beginning up to now, how the shipping industry evolved and the developments therein. It also discussed the global ranking of the seaports. The mergers and alliances of the shipping lines have also been discussed and the global increase of the container business also reviewed. Many other papers and reports regarding the Information Technology used in the seaports and cargo handling equipment have also been mentioned there. A clear upward trend in shipping volumes in the Asian region can be seen and more vessel traffic is also expected. At the same time ports and terminals in the Asian region are developing at a fast rate. That suggests that improvements in ICT in the ports in Sri Lanka have to be undertaken on an essential basis.

In Chapter 4 the research approach and methodology are discussed in detail and the results of the findings are analyzed in Chapter 5.

6.2 Research Findings

When the quayside crane (or STS crane) is not available for cargo handling operations due to various reasons, then there is a

- 80% probability that the reason for the non-availability is a breakdown.
- 20% probability that the reason for the non-availability is an accident, power failure and planning problem.
  (Please refer Appendix –D for details)

When there is a fault or breakdown in a quayside crane at JCT in SLPA, then, there is a

- 90 % probability that the crane would be released within 30 minutes after trouble shooting if the crane is the analog control type.
- 85% probability that the crane would be released within 30 minutes after trouble shooting if the crane is the digital control type.

When the crane is equipped with ICT systems (PLC digital control systems), the frequency of failure is much less when compared with the analog type cranes.

Hence, MTBF is much less for the cranes fitted with the PLC control system compared with that of cranes fitted with the analog type control system.

6.3 Conclusions.

When the number of ICT systems of a STS crane is high the productivity and availability is also high. The cost of new ICT systems comes down, as such implementation of proven ICT systems would be a good investment for the port of Colombo; because if the accuracy of container handling is high then there will be a positive response from the customers. At today's container throughput growth rate (see Table-2), a new STS crane would generate revenue exceeding the cost of such a crane

in less than one year.

For the Port of Colombo to be a Mega Container Hub, both SLPA and SAGT have to be developed to the same international level in Information and Communication Technology. At present SAGT is in a more advanced position when compared with SLPA. SLPA has a long and hard way to go to keep abreast with SAGT. Since international shipping lines look at Colombo as a location rather than a container terminal all the facilities in the Port of Colombo have to be improved to the same level.

6.4 Recommendations

- Introduction of one additional STS crane for each berth of JCT to improve crane availability. This will ease the operational division for releasing of STS cranes for scheduled maintenance. At the same time vessel productivity can be improved by engaging four cranes per vessel. (At present only 03 cranes per vessel are allocated most of the time)

- It is generally accepted that most electrical parts experience increasing breakdowns after 10-15 years service. Also, as electronics technology is progressing rapidly, components and parts are constantly superseded, with older models going out of production, making it very difficult to get spares. For the above reason and considering the payback period of a new crane, it is recommended that all STS cargo-handling equipment in SLPA, which are more than 20 years old, should be replaced.
  (Please note pay back period calculation for quay crane in Appendix-A)

- Implementation of an advanced Terminal Management System (TMS) with an equipment maintenance module for SLPA container terminals, JCT and UCT to minimize down times and increase crane availability.

- Introduction of Remote Monitoring and Maintenance System (RMMS) for new

STS cranes, which are scheduled to be procured in the coming year, to improve availability and minimize MTTR.

- Constant monitoring of the above system to increase cargo handling equipment efficiency and productivity and thereby the total productivity of the terminals.

- Entering into Trade Union(TU) agreements with the main Trade Unions to minimize delays and losses resulting from possible TU action.

- Proper documentation of the details of crane maintenance and the cost of maintenance (including cost of spares) allowing time to get equipment replacement and new procurement decisions easily.

- Implementation of a Port community system, which integrates the relevant information of SLPA, SAGT and other port stakeholders. In this system it is possible to interchange the required information electronically at a minimum cost and higher reliability.

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8 Appendix A: Payback Period Calculation for an Additional Crane

Table 8-1: SLPA container handling tariff (in US $)

Size	For transshipment	For Import and Export
20'	$37.00	$148.00
40'	$57.50	$228.00
45'	$71.00	$281.00

Source: Marketing Division, SLPA, June- 2006

Average approximate transshipment TEU to local TEU ratio = 65 : 35
(Source : Marketing Division SLPA, June- 2005)

For every three moves of containers = 2 X 20 foot containers + 1X40 foot container (Standard value for JCT- Port of Colombo)

For JCT terminal stage 3&4:

Average moves per crane per month = 8,000 moves

Average moves per crane per year = 12 X 8,000 moves
= 96,000 moves

Calculation of Revenue: (tariff for 45' container is taken as same as 40' container, since limited number of 45' containers have been handled in 2006)

Revenue from Transshipment = US $(1/3 X 96,000 X 57.5) X 65%+(2/3 X 96,000 X 37)X 65%
= US $2,735,200.00 per year / crane

Revenue from Local Cargo = US $(1/3 X 96,000 X 228)X 35% +(2/3 X 96,000 X 148) X 35%
= US $5,868,800.00 per year / crane

Total revenue per crane = US $ (5,868,800.00 + 5,868,800.00)
= US $ 8,604,000.00 per year

Approximate cost of STS crane =US $ 5,000,000.00

Pay back Period = US $ 5,000,000.00/ US $8,604,000.00 per year
= **0.58 years**
= **6.97 Months**

For JCT terminal stage 1&2:

Average moves per crane per month = 6,000 moves

Average moves per crane per year = 12 X 6,000 moves
= 72,000 moves

Calculation of Revenue: (tariff for 45' container is taken as same as 40' container, since only a limited number of 45' containers have been handled in 2006)

Revenue from Transshipment = US $(1/3 X 72,000 X 57.5) X 65%+(2/3 X 72,000 X 37)X 65%
= US $2,051,400.00 per year / crane

Revenue from Local Cargo = US $(1/3 X 72,000 X 228)X 35% +(2/3 X 72,000 X 148) X 35%
= US $4,401,600.00 per year / crane

Total revenue per crane = US $ (2,051,400.00 + 4,401,600.00)
= US $6,453,000.00per year

Approximate cost of STS crane = US $ 5,000,000.00

Pay back Period = US $ 5,000,000.00/ US $6,453,000.00per year

= 0.77 years

= 9.30 Months

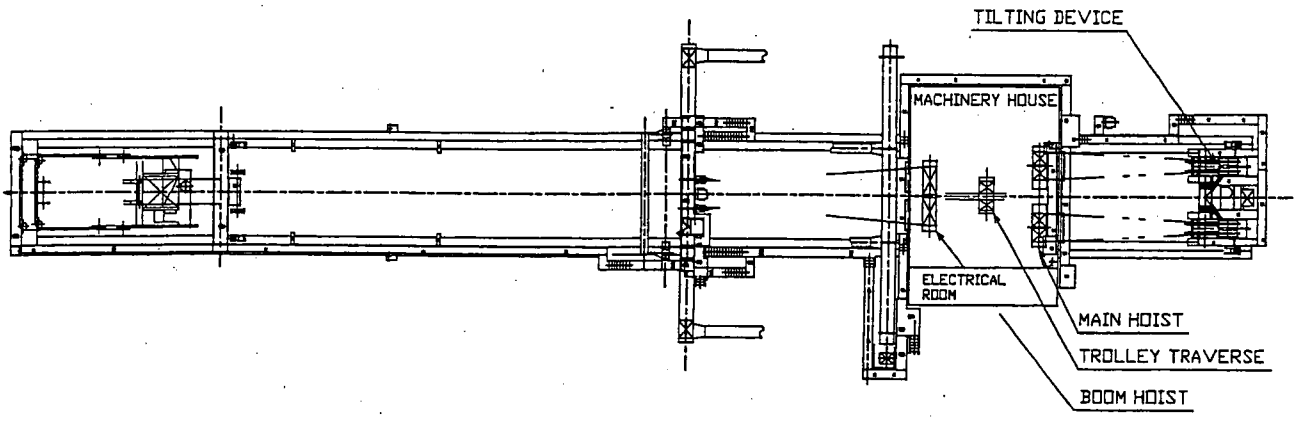
(Please note that a summary of results for all stages for JCT is given in the Tables 19,20 and 21 in pages 69 and 70)

9 Appendix B: Container Vessel in A Panama Locks

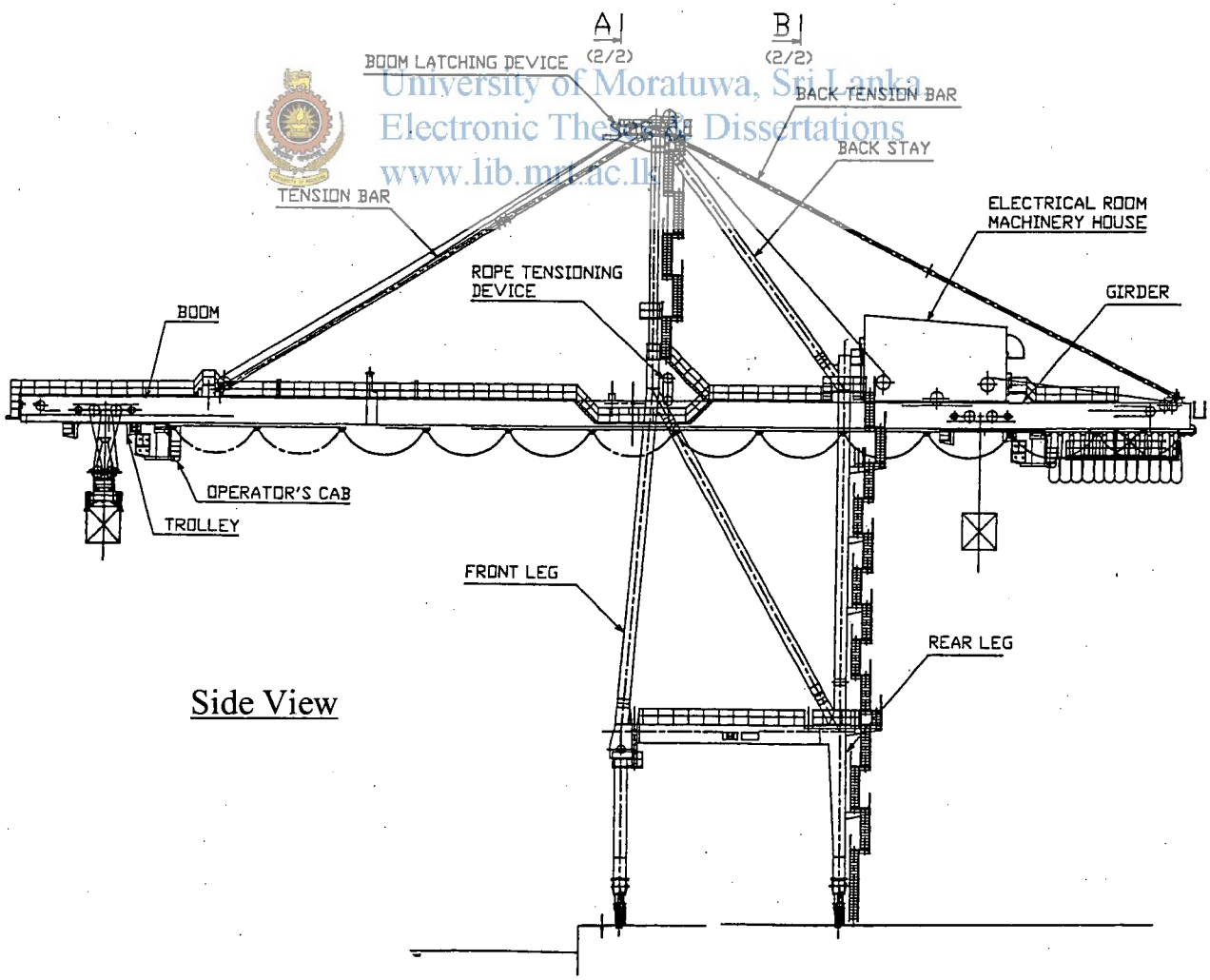
Source : Google Earth, June- 2006

Figure 9-1: Container Vessel in a Panama Locks

10 Appendix C: Main parts of Ship To Shore Crane

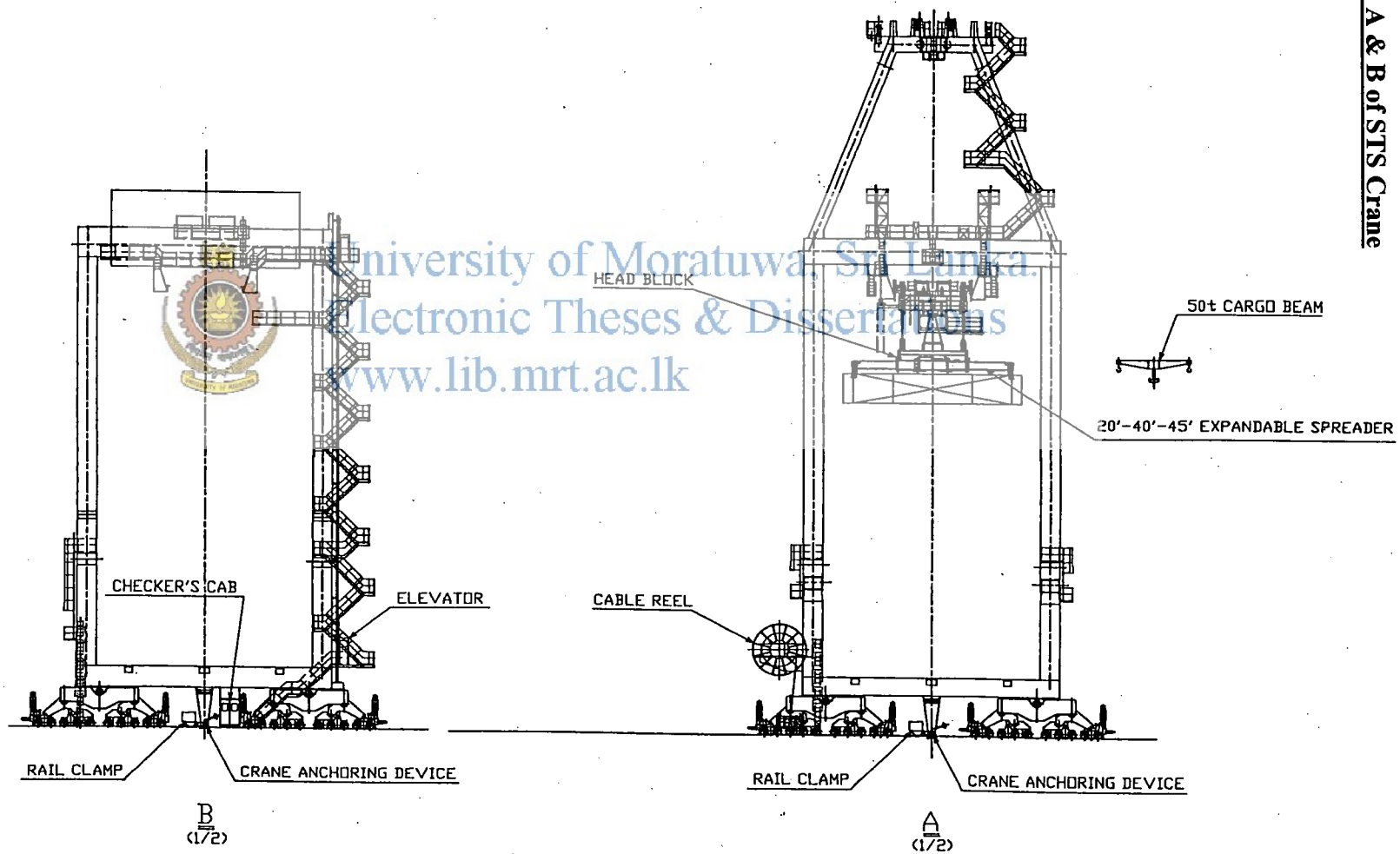


Top View



Side View

Sections A & B of STS Crane



11 Appendix D: Data Collection Form & Summary of Data

Data Collection Form

DATA COLLECTION FORM

Crane number PT

J	1	2	3		4		5	6		7	8	9			10	11	12		13	14

Year

Crane type Analog ☐ Digital ☐

Month

	Sprader							Main Hoist							Troley Travel							Gantry Travel							Boom Hoist							Mech.	Opera	other
	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7			
January																																						
February																																						
March																																						
April																																						
May																																						
June																																						
July																																						
August																																						
September																																						
October																																						
November																																						
December																																						

1	0-5	2	6-10	3	11-20	4	21-40	5	41-60	6	61- 180	7	More than 180

Summery

January																																						
February																																						
March																																						
April																																						
May																																						
June																																						
July																																						
August																																						
September																																						
October																																						
November																																						
December																																						

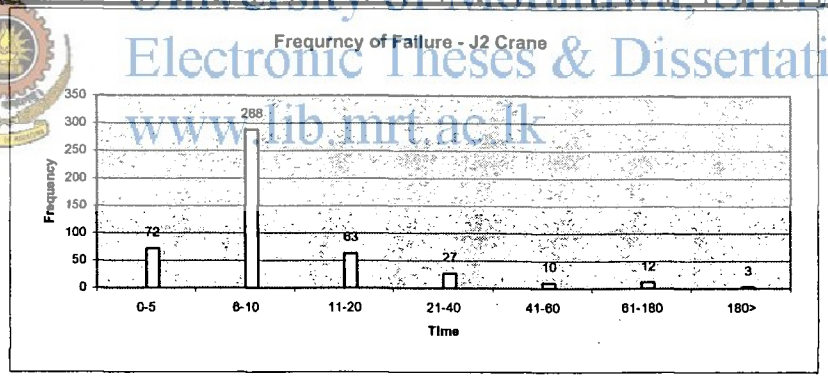
Crane number PT 3

SUMMARY OF B/D DATA

J	1	2	3		4		5	6		7	8	9			10	11	12		13	14
		X																		

Crane type Analog x Digital

Year	Spreader							Main Hoist							Trolley Travel							Gantry Travel							Boom Hoist							Mech.	Opera	other
	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7			
1985- Aug	0	0	2	0	1	0	0	7	10	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	2	3
1986	3	7	8	4	3	0	0	15	17	3	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	10	2	12
1987	4	10	10	2	0	0	1	13	50	7	4	0	1	0	0	0	0	0	0	1	1	0	1	1	0	0	0	0	0	0	1	0	1	0	0	19	27	13
1988	2	2	3	2	1	0	0	13	70	5	4	2	0	1	0	1	0	0	0	1	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0	34	12	16
1989	0	2	9	5	0	1	0	5	79	2	1	0	0	0	0	0	1	2	0	0	0	0	3	0	0	0	0	0	0	0	0	0	1	1	0	27	1	14
1990- July	1	2	5	2	1	2	0	9	30	1	0	0	2	0	0	1	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	13	0	9
Total	10	23	37	15	6	3	1	62	256	21	9	2	3	1	0	2	3	2	0	3	1	0	7	1	1	0	2	0	0	0	1	0	2	1	0	107	44	67



	Time(Min.)	Frequency	%	Rel. Freq. %
1	0-5	72	15.2%	15.2%
2	6-10	288	60.6%	75.8%
3	11-20	63	13.3%	89.1%
4	21-40	27	5.7%	94.7%
5	41-60	10	2.1%	96.8%
6	61-180	12	2.5%	99.4%
7	180>	3	0.6%	100.0%
	Total	475	100.0%	

Reason	Freq.	%
Electrical	475	68.54%
Mechanical	107	15.44%
Operational	44	6.35%
Other	67	9.67%
Total	693	100.00%

Summary of Breakdown Data for J2 Analog Control Crane

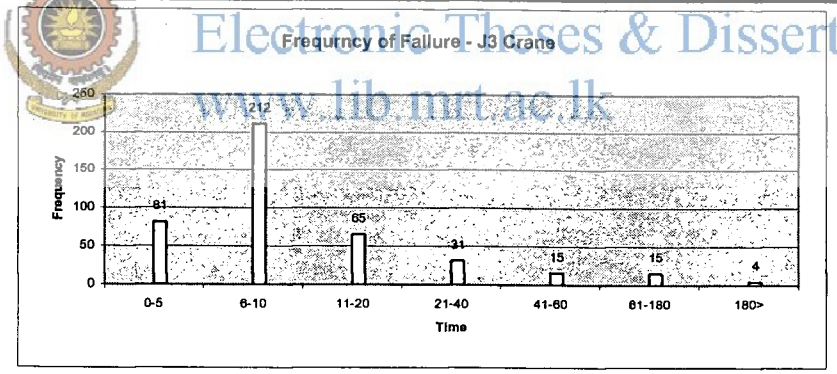
SUMMARY OF B/D DATA

Crane number PT 4

J	1	2	3		4		5	6		7	8	9			10	11	12		13	14
			X																	

Crane type Analog x Digital

Year	Spreader							Main Hoist							Trolley Travel							Gantry Travel							Boom Hoist							Mech.	Opera	other
	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7			
1985- Aug	0	8	3	1	4	0	0	0	8	0	0	0	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	1	0	0	1	2	2	2
1986	6	10	6	6	2	0	0	4	10	0	0	0	0	0	0	8	2	0	1	0	0	0	3	1	0	0	0	0	0	2	0	0	0	1	0	18	6	10
1987	8	18	5	2	1	1	0	14	11	4	2	2	1	1	0	7	1	0	0	1	1	0	2	0	0	0	0	0	0	2	1	0	0	0	0	17	14	11
1988	9	11	6	3	0	1	0	10	30	11	6	2	4	0	0	5	1	0	0	0	0	0	2	0	0	0	0	0	0	1	0	0	0	0	0	24	6	10
1989	7	10	4	0	1	3	0	7	17	12	1	0	1	0	0	7	2	0	0	0	0	0	3	0	0	0	0	0	0	1	0	1	0	0	0	32	2	9
1990- July	8	12	3	6	1	1	0	8	12	1	1	1	1	0	0	4	1	0	0	0	0	0	2	1	1	0	0	0	0	3	0	0	0	0	0	6	2	10
Total	38	69	27	18	9	6	0	43	88	28	10	5	7	1	0	33	7	0	1	1	2	0	12	2	1	0	0	0	0	10	1	2	0	1	1	99	32	52



	Time(Min.)	Frequency	%	Re %
1	0-5	81	19.1%	19.1%
2	6-10	212	50.1%	69.3%
3	11-20	65	15.4%	84.6%
4	21-40	31	7.3%	92.0%
5	41-60	15	3.5%	95.5%
6	61-180	15	3.5%	99.1%
7	180>	4	0.9%	100.0%
	Total	423	100.0%	

Reason	Freq.	%
Electrical	423	69.80%
Mechanical	99	16.34%
Operational	32	5.28%
Other	52	8.58%
Total	606	100.00%

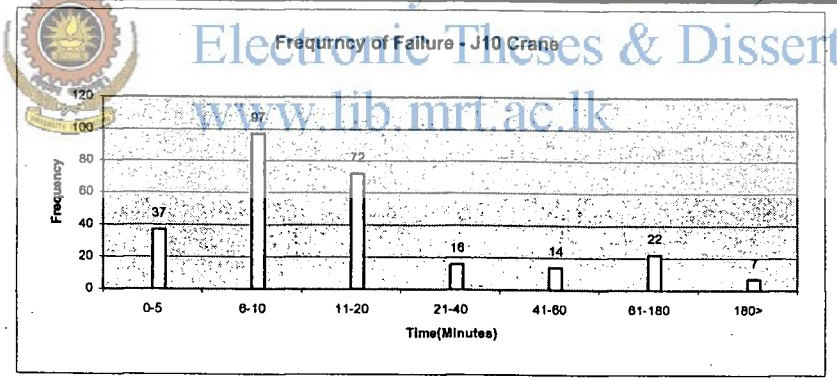
Crane number PT 11

SUMMARY OF B/D DATA

J	1	2	3		4		5	6		7	8	9			10	11	12		13	14
															X					

Crane type Analog | Digital X

Year	Spreader							Main Hoist							Trolley Travel							Gantry Travel							Boom Hoist							Mech.	Opera	other
	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7			
1995- Oct.	0	1	0	1	0	1	0	0	0	7	1	0	0	0		0	0	0	0	0	0		0	0	0	1	0	0		0	0	0	0	1	0	0	1	1
1996	0	0	7	1	2	2	0	0	1	4	1	0	0	0		0	1	2	0	0	0		0	0	0	0	0	1		0	0	0	2	0	0	15	5	4
1997	4	12	13	3	3	2	1	2	7	2	0	0	0	0		0	1	0	0	1	1		0	1	0	0	0	0		0	0	0	0	0	0	11	8	21
1998	4	7	9	1	2	2	0	1	3	4	0	0	6	0		0	0	0	0	0	0		0	0	0	0	0	0		0	0	0	0	0	0	20	3	7
1999	8	20	10	0	1	2	1	7	11	3	2	1	0	0		0	1	0	0	0	0		0	0	0	0	0	0		0	0	0	0	0	0	16	6	10
2000- Sept.	1	4	4	3	1	1	0	10	31	3	1	0	1	1		0	2	0	1	3	2		0	0	0	0	0	0		0	0	0	0	0	0	6	2	16
Total	17	44	43	9	9	10	2	20	53	23	5	1	7	1	0	0	5	2	1	4	3	0	0	1	0	1	0	1	0	0	0	0	2	1	0	68	25	59



	Time (Min.)	Frequency	%	Re %
1	0-5	37	14.0%	14.0%
2	6-10	97	36.6%	50.6%
3	11-20	72	27.2%	77.7%
4	21-40	16	6.0%	83.8%
5	41-60	14	5.3%	89.1%
6	61-180	22	8.3%	97.4%
7	180>	7	2.6%	100.0%
	Total	265	100.0%	

Reason	Freq.	%
Electrical	265	63.55%
Mechanical	68	16.31%
Operational	25	6.00%
Other	59	14.15%
Total	417	100.00%

Summary of Breakdown Data for J10 Digital Control Crane

Crane number PT 12

SUMMARY OF B/D DATA

J	1	2	3		4		5	6		7	8	9			10	11	12		13	14
																X				

Crane type Analog | Digital X

Year	Spreader							Main Hoist							Trolley Travel							Gantry Travel							Boom Hoist							Mech.	Opera	other
	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7			
1995- Oct.	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	2	3	4
1996	1	2	13	6	2	2	0	2	4	12	2	0	0	0	0	1	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	2	0	1	0	8	6	3
1997	3	5	8	2	0	3	1	2	3	4	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	17	5	18
1998	0	1	4	10	1	1	0	4	5	8	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	18	3	9
1999	8	15	9	1	1	3	0	2	5	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	19	8	22
2000- Sept.	7	9	23	4	1	3	1	4	8	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19	1	20
Total	19	32	57	23	5	12	2	14	25	33	3	0	1	1	0	2	1	0	0	2	0	0	1	1	0	0	0	0	0	0	2	3	1	1	0	83	26	76

88

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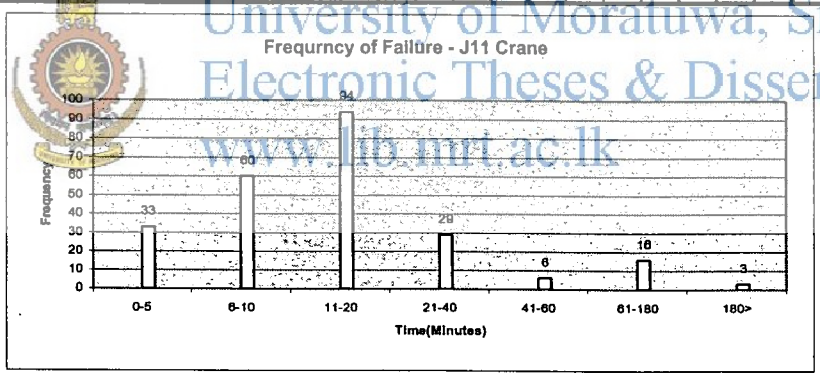

	Time (Min.)	Frequency	%	Re %
1	0-5	33	13.7%	13.7%
2	6-10	60	24.9%	38.6%
3	11-20	94	39.0%	77.6%
4	21-40	29	12.0%	89.6%
5	41-60	6	2.5%	92.1%
6	61-180	16	6.6%	98.8%
7	180>	3	1.2%	100.0%
	Total	241	100.0%	

Reason	Freq.	%
Electrical	241	56.57%
Mechanical	83	19.48%
Operational	26	6.10%
Other	76	17.84%
Total	426	100.00%

Summary of Breakdown Data for J11 Digital Control Crane