

**MEASURING PORT PERFORMANCE AT KELANG MULTI
TERMINAL SDN. BHD. (WESTPORT) USING SIMULATION MODEL**

A thesis submitted to the Graduate School in partial fulfillment of the
requirements for the degree Master of Science (Information Technology),

Universiti Utara Malaysia

By

Ng Hooi Jin



Sekolah Sivivazah
(Graduate School)
Universiti Utara Malaysia

PERAKUAN KERJA KERTAS PROJEK
(*Certification of Project Paper*)

Saya, yang bertandatangan, memperakukan bahawa
(*I, the undersigned, certify that*)

NG HOOI JIN

calon untuk Ijazah
(*candidate for the degree of*) Sarjana Sains (IT)

telah mengenukakkan kertas projek yang bertajuk
(*has presented his/her project paper of the following title*)

MEASURING PORT PERFORMANCE AT KELANG MULTI TERMINAL SDN. BHD.

(WESTPORT) USING SIMULATION MODEL

Seperli yang tercatat di muka surat tajuk dan kulit kertas projek
(*as it appears on the title page and front cover of project paper*)

bahawa kertas projek tersebut boleh diterima dari segi bentuk serta kandungan,
dan meliputi bidang ilmu dengan memuaskan.

(*that the project paper acceptable in form and content, and that a satisfactory
knowledge of the field is covered by the project paper*)

Nama Penyelia
(*Name of Supervisor*) : Prof. Madya Dr. Razman Mat Tahar

Tandatangan
(*Signature*) : S. Sathumangal

Tarikh
(*Date*) : 2 Mei 2011

PERMISSION TO USE

In presenting this thesis in partial fulfillment of the requirements for a postgraduate degree from Universiti Utara Malaysia, I agree that the University Library may make it freely available for inspection. I further agree that permission for copying of this thesis in any manner, in whole or in part, for scholarly purposes may be granted by my supervisor or, in their absence, by the Dean of the Graduate School. It is understood that any copying or publication or use understood that due recognition shall be given to me and to Universiti Utara Malaysia for any scholarly use which maybe made of any material from my thesis.

Requests for permission to copy or to make use of materials in this thesis, in whole or in part, should be addressed to:

Dean of Graduate School
Universiti Utara Malaysia
06010 UUM Sintok
Kedah Darul Aman.

ABSTRACT (BAHASA MALAYSIA)

Projek ini menerangkan pemodelan serta simulasi untuk proses pengoperasian kontena di Westport. Objectif utama projek ini adalah untuk mengukur persembahan operasi kontena di pelabuhan, terutamanya proses bermula daripada ketibaan kapal hingga pungkasannya. Projek ini menggunakan analisa statistik untuk mengukur input dan output hasil daripada model. Dalam bahagian analisis input akan mempersembahkan cara pengutipan data serta mengenal pasti andaian-andaian. Model dibentukkan dengan menggunakan Arena, sejenis perisian simulasi yang digunakan untuk simulasi yang bercorak discrete. Analisis output serta eksperimen model akan dijalankan selepas pembentukkan model dengan Arena. Pengesahan ke atas output model menunjukkan bahawa model yang dibentuk mewakili keadaan sistem sebenar. Akhir sekali, cadangan dikemukakan untuk memperbaiki persembahan operasi kontena di Westport.

ABSTRACT (ENGLISH)

This project describes the modeling and simulation of container operation at Westport. The main objective of this project is to evaluate the performance of the container handling at the port, commencing the arrival of ship until its departure. The project uses a statistical analysis method to measure the input and output for the model. For the input analysis section, it presents the data collection method and assumptions used. The model is built using Arena, simulation software used for discrete event simulation. The output analysis and model experimentation were carried after the completion of model building using Arena. The verification and validation of the output model showed the reliability and credibility of the model built to represent sufficiently accurate of the real system. Finally, some recommendations were present for the improvement of the container operation at Westport.

ACKNOWLEDGEMENTS

In presenting this project, I wish to thank my coordinator Dr. Razman, for his coordination, support and advise. Particular thanks go to Mr. Juswinder Singh, container terminal manager in Westport, for his help and cooperation on data and information collections. To all peoples in Westport container terminal department, for providing me clear explanations in port operation. Finally, I thank to my family and all friends for their support and help in this project.

LIST OF TABLES

Table	Page
1.1 Commodities export year 1992 and 1998	4
2.1 Container volume in KCT, KPM and Westport from 1996 to 1999	8
2.2 Summary of development in Westport from 1992 to 2001	15
2.3 Container volumes discharged in Westport from 1996 to 2000.	16
2.4 Conventional volumes in Westport Conventional Terminal from 1995 to 1999	19
2.5 Fastport standards for every type of cargo	21
2.6 News update in Westport From 1994 to 2000	27
4.1 Process time for each resource in Process module	64
4.2 Inputs in Leave module	65
4.3 Inputs in depart module	66
4.4 Calculation of probabilistic in each berth	68
4.5 Inputs in Arrive Module	71
4.6 Inputs in Server Module	76
4.7 Inputs in Depart Module	77
5.1 Data Verification for the Original data provided by Westport Statistic Dept.	80
5.2 Data Verification for the simulated data run by model vessel.doe	83
5.3 Total of time that vessels spend in port	82
5.4 Total of counts according to berth and crane allocation	84
5.5 Total containers in according to wharf	85
5.6 Hours vessels spend in port	86
5.7 Data Verification for the simulated data run by model container.doe	87
5.8 Comparison between actual data and simulated data	89
5.9 Rating of the utilizations level	92
5.10 Average time vessel spend in berth	93
5.11 Counts according to the crane allocation	94
5.12 The rating of utilizations according crane in berth	98
5.13 Inputs in Time-Persistent Statistic	100
5.14 Inputs in Time-Persistent Statistic	103

Table	Page
6.1 Comparison of result from 2 models	107
6.2 Comparison utilizations of resources between 2 models	107
6.3 Comparison of result from 2 models	108
6.4 Comparison utilizations of resources between 2 models	109
6.5 Comparison of result from 2 models	110
6.6 Summary of simulation result from model vessel_whatif_casestudy.doe	111
6.7 Comparison between manual calculation results and simulation results	112

LIST OF FIGURES

Figure	Page
2.1 Location of Westport	9
2.2 Network of Westport's worldwide container shipping service	9
2.3 Westport Organizational Chart	11
2.4 Summary of development and construction of Westport	15
2.5 Summary of infrastructure and equipment in Westport container terminal	17
2.6 Summary of infrastructure and equipment in Westport conventional terminal	20
2.7 Standard and services provided by Westport	23
3.1 Model representing real world system	28
3.2 Schematic of simulation study	29
4.1 Containers handling in Westport	42
4.2 Project Scope	47
4.3 Sub scope of the project	49
4.4 Total vessels visit the port in August	52
4.5 Types of vessels enter the port	53
4.6 Total vessel enter the wharf according to crane assignment	54
4.7 Number of crane assign to vessel according to wharf	55
4.8 Total vessels in the port	56
4.9 Histogram with the distribution normal for vessel interarrival time	57
4.10 Model vessel.doe	58
4.11 Entity	59
4.12 Arrive Module	60
4.13 Station Module	61
4.14 Read Module	61
4.15 Choose Module	62
4.16 Enter Module	62
4.17 Delay Module	63
4.18 Process Module	64
4.19 Leave Module	65

Figure	Page
4.20 Depart Module	66
4.21 Simulate Module	67
4.22 Chance Module	68
4.23 Model container.doe	69
4.24 Entity	70
4.25 Arrive Module	71
4.26 Station Module	72
4.27 Read Module	73
4.28 Choose Module	74
4.29 Delay Module	75
4.30 Server Module	76
4.31 Depart Module	77
4.32 Simulate Module	78
5.1 Statistic Module in model vessel.doe	99
5.2 Statistic Module for model container.doe	102
6.1 Chance Module	106

TABLE OF CONTENTS

	Page
PERMISSION TO USE	i
ABSTRACT (BAHASA MALAYSIA)	ii
ABSTRACT (ENGLISH)	iii
ACKNOWLEDGEMENTS	iv
LIST OF TABLES	v
LIST OF FIGURES	vii
TABLE OF CONTENTS	ix
CHAPTER ONE: INTRODUCTION	1
1.1 Contribution of port to economy development	1
1.2 Port system studies	2
1.3 Containerization concept	3
1.3.1 The importance of containerization	3
1.4 Method of analysis	4
1.5 Malaysian ports	4
1.5.1 Penang Port	5
1.5.2 Port Klang	5
1.5.3 Johor Port	6
1.6 Objectives and scope of study	6
1.7 Project overview	7
CHAPTER TWO: BACKGROUND OF KELANG MULTI TERMINAL SDN. BHD. (WESTPORT)	8
2.1 Location	8
2.2 History	10
2.3 Westport structure organization	10
2.4 Performance	12
2.4.1 Westport voted Asia's top best container terminal	12
2.4.2 Infrastructure and facilities	13
2.4.3 The future	14
2.5 Westport Container Terminal	16

	Page
2.6 Westport Conventional Terminal	18
2.6.1 Break bulk	18
2.6.2 Dry bulk	19
2.6.3 Liquid bulk	19
2.7 Westport concepts	21
2.7.1 The Fastport concept	21
2.7.2 The Flexiport concept	24
2.7.3 The Gardenport concept	24
2.8 Others support	24
2.8.1 Distri Park	24
2.8.2 Vehicle Terminal Centre	25
2.8.3 IT and G-Links System	25
2.8.4 Feeder system and haulage	25
2.9 Westport financial report	26
2.10 The Westport update	27
CHAPTER THREE: LITERATURE REVIEW	28
3.1 Definition of model	28
3.2 Definition of simulation	28
3.3 Previous studies in port simulation modeling	30
3.3.1 Shipping traffic flow	30
3.3.2 Traffic control system	31
3.3.3 Container flows	32
3.3.4 Simulation model for Container Terminals	32
3.4 Other simulation studies	33
3.4.1 Transportation simulation	33
3.4.2 Simulation of a machining and assembly line	34
3.4.3 Battlefield-simulation	34
3.4.4 Airport simulation	34
3.5 Tools and technology for simulation modeling	35
3.6 When to use simulation modeling	36
3.7 Benefits of using simulation modeling	38
3.8 Drawbacks of simulation modeling	39

	Page
3.9 Conclusion	40
CHAPTER FOUR: METHODOLOGY	41
4.1 Overview	41
4.2 Steps for getting started Simulation project	43
4.2.1 Problem statement	43
4.2.2 Understand the system	44
4.2.3 Objectives and scope determination	45
4.2.4 Assumptions formulation	50
4.3 Input Analysis	51
4.3.1 Data collection	51
4.3.2 Model development	57
CHAPTER FIVE: OUTPUT ANALYSIS	79
5.1 Data verification and validation	79
5.1.1 Verification on original data provided by Westport Statistic Department	79
5.1.2 Verification on simulated data run by model	82
5.1.3 Comparison between actual data and simulated data	88
5.2 Output Analysis	91
5.2.1 Level of utilizations for each berth	91
5.2.2 Cranes utilizations analysis	93
5.3 Analysis result run from Arena Output Analyzer	99
5.4 Understand the model's limitations	105
CHAPTER SIX: MODEL EXPERIMENTATION	106
6.1 Vessel suppose have the same branching probabilistic to enter the berth	106
6.2 Reduce 3 cranes assignment to 2 cranes	108
6.3 One of the berths shot down for one month	110
6.4 A Case Study	111
CHAPTER SEVEN: RECOMMENDATION AND CONCLUSION	113
BIBLIOGRAPHY	115
APPENDIX	119

CHAPTER ONE: INTRODUCTION

1.1 Contribution of port to economy development

Malaysia has made a quick economic recovery in 1999 from its worst recession since independence in 1957. Gross Domestic Product (GDP) grew 5%, responding to a dynamic export sector, which grew over 10% and fiscal stimulus from higher government spending. The large export surplus has enabled the country to build up financial reserves, to \$31 billion at yearend 1999. Government and private forecasters expect Malaysia to continue this trend in 2000, predicting GDP to grow another 5% to 6%. [3] In the service sector, services output increased by 2.9% in the first quarter of 1998, following 7.9% growth in 1997. Services accounted for 44.8% of GDP in 1997. Finance and insurance recorded strong gains, while utilities, transportation, and communications were affected by the slowdown in exports. The services sector recorded US\$8.7 billion in 1997. The government has undertaken efforts to promote Malaysia's shipping and reinsurance industries improve and expand port and air transportation. Ports play a pivotal role in the economic development of the country. Malaysia government continues in the projects investment, those projects include various port development, highway, water supply, and waste disposal and sewerage projects. [17]

Besides, according to Port World Sdn. Bhd. (2000), The future growth of container trade at principal containers ports in Malaysia is expected to strongly fuel by the continued expansion in transshipment traffic. The growth in transshipment traffic in year 2000 made 37% of the total container trade, the share could rise to about 50% this year (or about 4.3 million TEUs). Port services generate foreign exchange earnings (for non-Malaysian containers handled) and bring savings in foreign exchange (for Malaysian container traffic handled at local port rather than via a foreign port). Foreign exchange contributions from transshipment handled at local ports in year 2001 could top RM400 million. This is a significant sum that needs national strategies to be formulated to foster its growth. [28] Refer the growth rate of total traffic at selected Malaysian ports in Appendix A.

The contents of
the thesis is for
internal user
only

BIBLIOGRAPHY

- [1] Anu Maria (1997), *Introduction to modeling and simulation*, Proceedings of the 1997 Winter Simulation Conference.
- [2] Civil Engineering Consultants, *Young-glencoe Port Simulation Modelling*, (no date) [Online]. Available HTTP: <http://www.young-glencoe.demon.co.uk/page2.html>
- [3] CIA - *The World Factbook 2000 - Malaysia*, (2000) [Online]. Available HTTP: <http://www.cia.gov/cia/publications/factbook/geos/my.html>
- [4] *Containerization*, (no date) [Online]. Available HTTP: <http://www.worldtradoclub.net/doc/wtArt081.htm>)
- [5] Design Eng. Lab., Dept. of EOE, School of Eng., the Univ. of Tokyo. (2000) *Transport Simulation*, [Online]. Available HTTP: <http://www.nakl.t.u-tokyo.ac.jp/research/transport/>
- [6] Flow Software Technologies, Workspace5 Software Product Information- *Why Simulation*, (no date) [Online]. Available HTTP: <http://www.workspace5.com/products/whysim.html>
- [7] G.J. Van de Ruit, M. Van Schuylenburg and J. A. Ottjes (June, 1995) *Simulation of Shipping Traffic Flow In the Maasvlakte Port Area of Rotterdam*, [Online]. Available HTTP: <http://www-tt.wbmt.tudelft.nl/users/duinker/papers/pra9506.pdf>
- [8] Hans P.M. Veeke and Jaap A. Ottjes (Oct, 1999) *Detailed Simulation of the Container flows for the IPSI-concept* [Online]. Available HTTP: <http://www-tt.wbmt.tudelft.nl/users/duinker/papers/erl9910a.pdf>
- [9] Hans P.M. Veeke and Jaap A. Ottjes (Oct, 1999), *Simulation of a New Port-Ship Interface Concept for Inter Model Transport*, [Online]. Available HTTP: <http://www-tt.wbmt.tudelft.nl/users/duinker/papers/erl9910b.pdf>
- [10] Hanif D. Sherali, Antoine G. Hobeika, Antonio A. Trani, and Byung J. Kim (1992), *An Integrated Simulation and Dynamic Programming Approach for Determining Optimal Runway Exit Locations*, Management Science, Vol. 38. No. 7, July 1992.
- [11] Jaap A. Ottjes, S. Hengst, W.H. Tutuarima (June, 1994), *A Simulation Model of A Sailing Container Terminal Service in Port of Rotterdam*, [Online]. Available HTTP: <http://www-tt.wbmt.tudelft.nl/users/duinker/papers/bar9406.pdf>

- [12] Jack P. C. Kleijin, Bert Bettonvil, Willem Van Groenendaal (1998), *Validation of Trace-Driven Simulation Models: A Novel Regression Test*, Management Science, Vol.44, No. 6, June 1998.
- [13] Jerry Banks and Randall R. Gibson, *Getting Started in Simulation Modeling*, (no date) [Online]. Available HTTP: <http://www.aaisim.com/PubNov96Right.htm>,
- [14] *Johor port*, (no date) [Online]. Available HTTP: <http://www.joport.com.my/introduction/index.html>
- [15] Kenneth D. Forbus (1996), *Why simulation modeling should become a popular hobby*, D-Lib magazine, October 1996, ISSN 1082-9873, [Online]. Available HTTP: <http://www.qrg.nwu.edu/papers/Files/simhobby-local.htm>
- [16] Kenneth J. Musselman (1994), *Guidelines For simulation Project success*, Proceedings of the 1994 Winter Simulation Conference.
- [17] *Malaysia: economic trends and outlook*, (no date) [Online]. Available HTTP: <http://www.tradeport.org/ts/countries/malaysia/trends.html>
- [18] Mark B.Duinkerken, Joseph J.M.Evers and Jaap A.Ottjes (July, 1999), *TRACES: Traffic Control Engineering System, A case study in container terminal automation*, [Online]. Available HTTP: <http://www-tt.wbmt.tudelft.nl/users/duinkerk/papers/chi9907b.pdf>
- [19] Mark B.Duinkerken and Jaap A.Ottejes (April, 2000), *A Simulation Model for Automated Container Terminals*, [Online]. Available HTTP: <http://www-tt.wbmt.tudelft.nl/users/duinkerk/papers/was0004a.pdf>
- [20] McHaney, Roger., *Computer Simulation: a practical perspective*, Academic Press Limited, United States, 1991.
- [21] *PKA Site*, (no date) [Online]. Available HTTP: <http://www.pka.gov.my/frame.htm>
- [22] Ray K. Linsley and Norman H. Crawford, *Why simulation?* <http://www.hydrocomp.com/whysim.html>
- [23] Richard L. Smith and Lucille Platt (1987), *Benefits of animation in the simulation of a machining and assembly line*, Simulation, January 1987.
- [24] Robert E. Shannon (1998), *Introduction to the art and science of simulation*, Proceedings of the 1998 Winter Simulation Conference.

- [25] SimResource. Com (2000), *simresource - Benefits of Using Simulations*, [Online]. Available HTTP: <http://www.simresource.com/buy/userbenefits.shtml>
- [26] SimResource. Com (2000), *simresource - When to use simulations*, [Online]. Available HTTP: <http://www.simresource.com/buy/whensimulate.shtml>
- [27] *Trends in Containerization*, (no date) [Online]. Available HTTP: http://151.121.3.151/tmd/IPGrain/trends_in_containerization.htm
- [28] *The Malaysian maritime cyber hub*, (no date) [Online]. Available HTTP: <http://www.portsworld.com/Ports/penangport.htm>
- [29] Westport(2001), *Westport - Introduction*, [Online]. Available HTTP: <http://www.westportmalaysia.com/introduc.htm>
- [30] Westport(2001), *Westport - History*, [Online]. Available HTTP: <http://www.westportmalaysia.com/history.htm>
- [31] Westport (2001), *Westport - Westport concept*, [Online]. Available HTTP: <http://www.westportmalaysia.com/westport3.htm>
- [32] Westport (2001), *Westport - Fastport concept*, [Online]. Available HTTP: <http://www.westportmalaysia.com/fastport.htm>
- [33] Westport (2001), *Westport - Flexiport concept*, [Online]. Available HTTP: <http://www.westportmalaysia.com/flexiport.htm>
- [34] Westport (2001), *Westport - Garden port concept*, [Online]. Available HTTP: <http://www.westportmalaysia.com/garden.htm>
- [35] Westport (2001), *Westport - Infrastructure*, [Online]. Available HTTP: <http://www.westportmalaysia.com/infrastr.htm>
- [36] Westport (2001), *Distri Park*, [Online]. Available HTTP: <http://www.westportmalaysia.com/other.htm>
- [37] Westport (2001), *Westport - Tower Block*, [Online]. Available HTTP: <http://www.westportmalaysia.com/tower.htm>
- [38] Westport (2001), *Westport - IT SYstem & G-Links*, [Online]. Available HTTP: <http://www.westportmalaysia.com/it1.htm>
- [39] Westport (2001), *Westport - Feeder System & Haulage*, [Online]. Available HTTP: <http://www.westportmalaysia.com/feeder.htm>

- [40] Westport (2001), *Westport - Container*, [Online]. Available HTTP: <http://www.westportmalaysia.com.my/container.htm>
- [41] Westport (2001), *Westport - Conventional Operations*, [Online]. Available HTTP: <http://www.westportmalaysia.com/conventi.htm>
- [42] Westport (2001), *Westport - Financial Reports*, [Online]. Available HTTP: <http://www.westportmalaysia.com.my/financial.htm>
- [43] Westport (2001), *Westport - Vision*, [Online]. Available HTTP: <http://www.westportmalaysia.com/vision.htm>
- [44] Westport (2001), *WestPort - Port Klang & 1999 World Port Rankings*, [Online]. Available HTTP: <http://www.westportmalaysia.com.my/rankings.htm>
- [45] Westport (2001), *Westport - Equipment, Specifications & Facilities*, [Online]. Available HTTP: <http://www.westportmalaysia.com/equipmen1.htm>
- [46] Westport (2001), *Liquid Bulk*, [Online]. Available HTTP: <http://www.westportmalaysia.com/liquid.htm>
- [47] Westport (2001), *Westport Malaysia - Break Bulk*, [Online]. Available HTTP: <http://www.westportmalaysia.com/break.htm>
- [48] Westport (2001), *Dry Bulk*, [Online]. Available HTTP: <http://www.westportmalaysia.com/drybulk.htm>
- [49] Westport (2001), *Vehicle Termination Centre*, [Online]. Available HTTP: <http://www.westportmalaysia.com/vehicle.htm>
- [50] W. Lewis Johnson and others (1995), *Intelligent Agents for Interactive Simulation Environments*, AI Magazine, spring 1995.