TECHNICAL AND COST MODEL FOR SLIPWAY DEVELOPMENT

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To my precious and beloved father and late mother, for the love and prays during the day and night,

Whom I dedicate this work with great respect and love,

Eternally...

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In the name of Allah, Most Gracious, Most Merciful. Praise be to Allah, The Cherisher and Sustainer of the worlds; Most Gracious, Most Merciful; Master of The Day of Judgment. The do we worship, and Thine aid we seek. Show us the straightway, the way of those whom Thou has bestowed Thy grace, those whose (portion) is nor wrath, and who go not astray. This thesis is the testimony of the fact that by having faith in Allah, the impossible is made possible. Many times I reached dead ends; many times I felt frustrated and stressful; it is in Him I found the strength, peace and hope to carry on.

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ABSTRACT

In recent years, the discussion and progression of slipway construction in Malaysia is developing extensively due to the growth of the fleets registered in the country. In conjunction with the slipway constructions, it is crucial for the developer to have an early estimation of the principal dimensions of the slipway as well as the final cost since the development of the slipway involves a huge cost. The technical and cost estimation tools are oftenly used by the key person in the project management team to identify the technical feature and cost involved in slipway construction project. Therefore, this research is aimed at developing a model to identify the principal dimensions of the slipway including length, breadth, maximum capacity, angle, cradle size and construction cost. The technical and cost model developed can be used as a tool to support the developer in performing the decision making during the pre-design stage of the slipway development project. The model was developed by performing regression analysis to the collected historical data from the previous slipway projects in Malaysia. A total of thirteen (13) mathematical equations to identify the slipways' principal dimension and construction cost has been successfully generated. An Excel package for technical and cost model have also been developed. The package has been verified by substituting the historical data in order to determine the limitations of the package. The technical and cost model package was deemed appropriate for the slipways with capacity between 277 tones to 3363 tones. At the end of the research, the package has been tested to determine the accuracy of the output was validated by comparing the results against the real world data from Slipway Kuala Linggi Project. The highest error found was only 13.1% for the slipway length variables, showing that the package resembles the real world data. Therefore, the technical and cost model developed is considered relevant to both industry practitioners and academic researchers.

ABSTRAK

Kebelakangan ini, pembinaan tempat pelancaran kapal semakin meningkat iaitu selari dengan pertambahan bilangan kapal yang berdaftar di Malaysia. Seiring dengan perkembangan ini, adalah penting bagi pemaju menganggar parameter utama tempat pelancaran kapal ini dan sekaligus menganggar kos yang diperlukan untuk membina tempat pelancaran kapal yang mana ia melibatkan kos yang sangat tinggi. Teknikal dan kos model seringkali diguna pakai oleh orang yang berkepentingan dalam industri pembinaan tempat pelancaran kapal walaupun kejituan keputusan yang diperolehi itu berkemungkinan rendah. Kajian ini menumpukan terhadap pembinaan model untuk mengenal pasti parameter utama panjang, lebar, kebolehan maksimum, sudut, dan kos pembinaan bagi tempat pelancaran kapal. Model ini boleh digunakan sebagai medium utama dalam peringkat awal merekabentuk tempat pelancaran kapal. Model ini dibina dengan mengaplikasikan analisis regresi terhadap data yang diperolehi daripada projek-projek pembinaan tempat pelancaran kapal yang terdahulu di Malaysia. Sejumlah tiga belas (13) persamaan matematik untuk mengenal pasti parameter utama tempat pelancaran kapal dan kos pembinaan telah berjaya dihasilkan. Pakej '*Excel'* juga telah dibina untuk mengenal pasti parameter teknikal dan kos pembinaan tempat pelancaran kapal. Pakej ini telah disahkan dengan menggunakan data yang terdahulu untuk menentukan had kebolehan pakej dalam menentukan parameter utama dan kos pembinaan tempat pelancaran kapal. Teknikal dan kos model yang dibina sesuai untuk pelancaran kapal dengan kapasiti antara 277 hingga 3363 ton. Pada akhir kajian ini, pakej yang telah diuji untuk menentukan ketepatan output. Pakej ini telah disahkan dengan membandingkan data sebenar dari tempat pelancaran kapal Projek Kuala Linggi. Ralat paling tinggi didapati hanya 13.1% bagi panjang tempat pelancaran kapal. Oleh itu, model yang dibina dianggap bermanfaat untuk sektor industri dan juga penyelidik akademik.

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

Slipways are structures to transfer vessels to or from water for temporary storage of ship repair or new ship building purposes. Maintenance and repair are required by all vessels to keep them in good conditions. Furthermore, it is an obligatory for a vessel to be pulled up for checking and inspection every five years (Soric. Z, 2005). These requirements made slipways and other dry docking methods to be the workhorses of the ship repair facilities.

Slipways are extensively used in small yards in Malaysia to accommodate small or medium size vessels. The slipways are widely used in ship repair and ship building industries before the existence of another method of the new technologies such as dry dock, ship lift and floating dock. However, till now the slipways play important role in the ship repair industries due to minimal cost for the ship owner compared to the other methods with the new technologies.

According to Mackie et al. (2006), usually slipways can accommodate vessel weight up to 3000 ton. However, it is a high risk to load any vessel more than such weight due to safety issues as the stability of the vessel on the slipway totally depends on the center of gravity of the vessel. Hence, loading a vessel with more than the stated weight will lead to a risk of collapse.

Generally, the main component of a slipway consists of winch, rail track and cradle. However, the critical element is the rail track as highlighted by Mackie et al. (2006). The rail track is made up of a deck system with a flat slab and is supported with bore cast in situ piles.

Slipway construction project evolved through a series of stages, beginning from the preliminary study, followed by several design stages and finally implementation of the design through the actual construction. In conjunction with such stages, preliminary design and cost estimation are very important for the developer or project owner. According to Yaman (2007), since 1950s efforts have been made to understand the cause-effect relationship between design parameters and the construction cost as well as to develop a model in estimating the construction cost.

The research addressed the need of a user friendly and reliable technical and cost estimation model on slipway construction during early stage of a project and proposed a conceptual technical and cost estimation method that relies on information known before the detailed plan and specifications identified. Prediction model for the principal dimension and size of the cradle is developed using regression analysis. The data used is collected from the shipyards with slipways in Malaysia.

The model developed in this research can be used as a tool to assist the developer or project owner to identify the particulars of the slipway including the length, breadth, angle of the slipway as well as the cradle size and the required funding for the overall slipway construction project. Users only need to state the desired design criteria such as length, breadth, draft and deadweight by referring to the maximum vessel to be slipped on the slipway. The model will perform the calculation and produce the output for the principal dimension of the slipway and the cost to be incurred in the construction process.

1.2 Statement of Problem

Generally, slipway is the most cost effective dry docking method for small vessels. It is not worth to docking vessels up to 3000 tons on dry dock, ship lift or floating dock since the cost would be slightly higher compared to docking on a slipway. The higher cost is the resultant of the higher technology used special and complex design of the docking system which is more suitable for larger vessels.

According to the list of ship registered to Malaysia Marine Department, there are 2150 numbers of ships have a deadweight less than 3000 ton. The detail data is presented in Table 1.1.

Table 1.1: Number of vessel registered to Malaysia Marine Department based on DWT (http://www.marine.gov.my/jlmeng/index.asp, 26 Feb 2012)

Deadweight (Ton)	<3000	3000-10000	10000-20000	>20000
No. of Vessel	2150	1333	420	300

Based on the data, it can be interpreted that slipways will be more demanding in Malaysia since the vessels with capacity of 3000 ton are higher in number compared to other capacities. However, the current developer or shipbuilders are potentially facing many challenges to design and construct the slipway since there is no coherent design theory and pre-design cost estimation which is the crucial elements to construct the slipway. Hence, an effort is necessitated to fill in the gap as to facilitate the requirement of slipway development.

As mentioned by Mackie (2006), specialized theory is required in designing and determining the cost of the slipway. It is not a rocket science but road geometrics of civil engineering as well as hydrostatics and stability analysis from naval architecture side are required. Considering such thought, this research attempts to develop simple mathematical equations to identify the principal dimension of the slipway and the early cost estimation.

In the early stage or pre-design stage, most basic and functional decisions which comprised of principal dimensions and construction cost should be made by the developer or project owner. The developer or project owner required a technique or a system to emphasise and prioritise their effort to control the project cost, otherwise worst impact will affect the total cost of the slipway construction project. Therefore, the mathematical equations developed in the current study will benefit the developer and project owner in managing the project by predicting the basic principal dimension and estimating the slipway construction cost.

1.3 Research objective

The objective of this research as per following:-

- To develop a technical model for a main slipway parameters.
- To develop a cost model for slipway construction.
- To develop an excel package which can be used as a tool for predicting the principal dimension and cost of the slipway construction.

1.4 Scope of the research

The scopes of the research are as follows.

i. This research will develop a cost model for slipway which based on technical and construction parameter applicable in Malaysia.

ii. This research focusing on quantitative parameters only.
iii. The technical and cost model includes only the slipway main parameters and the construction cost for the main components of the slipway while the overhead cost are excluded
iv. The cost model developed focuses on the construction cost only while the land price are neglected
v. The historical data is collected from the shipyards in Malaysia only

1.5 Structure of Thesis

This thesis is divided into six chapters. Each chapter has been partitioned into few parts where each part has its own sectioning. The sectioning and partitioning have been carefully done hence the content and the positioning emphasise the whole flow of the dissertation.

Chapter 1 is the introduction of the research which contains five parts including the background of the research, the problem statement, the objective and the scope of the research. Chapter 2 reviews all topics which are essential to understand the detail of the research and hence the content is related to the literature on slipway design, technical and cost model as well as the regression analysis. Chapter 3 overviews the detail of the methodology applied in the research which covers all the utilized methods and activities performed towards achieving the required results. Chapter 4 presents the result generated from the study which is further discussed in Chapter 5. Finally, chapter 6 concludes and highlights research achievements and makes some recommendations for the possible continuation of the research.

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APPENDICES

Technical data for Geliga Slipway 1

DESCRIPTION	ITEM	UNIT	VALUE
Limitation Factor	Vessel Length (Max)	m	32
	Breadth (Max)	m	10
	Deadweight	tonnes	400
	Vessel Draft (Max)	m	2.6
Slipway Parameter	Length of Slipway	m	65
	Breadth of Slipway	m	15
	Maximum Capacity	tonnes	500
	Angle of Slipway	degree	2
Cradle Parameter	Length of Cradle	m	34
	Breadth of Cradle	m	16

Technical data for Geliga Slipway 2

DESCRIPTION	ITEM	UNIT	VALUE
Limitation Factor	Vessel Length (Max)	m	40
	Breadth (Max)	m	13
	Deadweight	tonnes	600
	Vessel Draft (Max)	m	2.8
Slipway Parameter	Length of Slipway	m	85
	Breadth of Slipway	m	21
	Maximum Capacity	tonnes	600
	Angle of Slipway	degree	2
Cradle Parameter	Length of Cradle	m	45
	Breadth of Cradle	m	17

Technical data for Geliga Slipway 3

DESCRIPTION	ITEM	UNIT	VALUE
Limitation Factor	Vessel Length (Max)	m	45
	Breadth (Max)	m	15
	Deadweight	tonnes	1000
	Vessel Draft (Max)	m	3.0
Slipway Parameter	Length of Slipway	m	103.5
	Breadth of Slipway	m	25
	Maximum Capacity	tonnes	1000
	Angle of Slipway	degree	2
Cradle Parameter	Length of Cradle	m	49
	Breadth of Cradle	m	20

Technical data for Muhibbah Engineering

DESCRIPTION	ITEM	UNIT	VALUE
Limitation Factor	Vessel Length (Max)	m	55
	Breadth (Max)	m	16
	Deadweight	tonnes	1000
	Vessel Draft (Max)	m	3.0
Slipway Parameter	Length of Slipway	m	150
	Breadth of Slipway	m	21.33
	Maximum Capacity	tonnes	1000
	Angle of Slipway	degree	2.5
Cradle Parameter	Length of Cradle	m	55
	Breadth of Cradle	m	21

Technical data for Sapor Engineering

DESCRIPTION	ITEM	UNIT	VALUE
Limitation Factor	Vessel Length (Max)	m	80
	Breadth (Max)	m	20
	Deadweight	tonnes	3000
	Vessel Draft (Max)	m	3.4
Slipway Parameter	Length of Slipway	m	210
	Breadth of Slipway	m	30
	Maximum Capacity	tonnes	3200
	Angle of Slipway	degree	3
Cradle Parameter	Length of Cradle	m	82
	Breadth of Cradle	m	24

Technical data for University Kuala Lumpur

DESCRIPTION	ITEM	UNIT	VALUE
Limitation Factor	Vessel Length (Max)	m	42
	Breadth (Max)	m	8
	Deadweight	tonnes	250
	Vessel Draft (Max)	m	1.8
Slipway Parameter	Length of Slipway	m	98
	Breadth of Slipway	m	10
	Maximum Capacity	tonnes	300
	Angle of Slipway	degree	1.8
Cradle Parameter	Length of Cradle	m	34.5
	Breadth of Cradle	m	10

Technical data for Sarawak Slipway

DESCRIPTION	ITEM	UNIT	VALUE
Limitation Factor	Vessel Length (Max)	m	50
	Breadth (Max)	m	16
	Deadweight	tonnes	1800
	Vessel Draft (Max)	m	3.2
Slipway Parameter	Length of Slipway	m	80
	Breadth of Slipway	m	20
	Maximum Capacity	tonnes	2000
	Angle of Slipway	degree	0.8
Cradle Parameter	Length of Cradle	m	64
	Breadth of Cradle	m	20

Technical data for Prospect Dockyard

DESCRIPTION	ITEM	UNIT	VALUE
Limitation Factor	Vessel Length (Max)	m	35
	Breadth (Max)	m	8
	Deadweight	tonnes	250
	Vessel Draft (Max)	m	1.2
Slipway Parameter	Length of Slipway	m	70
	Breadth of Slipway	m	10
	Maximum Capacity	tonnes	300
	Angle of Slipway	degree	0.7
Cradle Parameter	Length of Cradle	m	33
	Breadth of Cradle	m	12

Technical data for Tok Bali Dockyard

DESCRIPTION	ITEM	UNIT	VALUE
Limitation Factor	Vessel Length (Max)	m	38
	Breadth (Max)	m	15
	Deadweight	tonnes	500
	Vessel Draft (Max)	m	1.6
Slipway Parameter	Length of Slipway	m	96
	Breadth of Slipway	m	18
	Maximum Capacity	tonnes	500
	Angle of Slipway	degree	1.2
Cradle Parameter	Length of Cradle	m	39
	Breadth of Cradle	m	20

Total and breakdown cost for slipway construction

No	SHIPYARD	COST ELEMENT							
		Engineering (RM)	Earthwork (RM)	Cradle (RM)	Rail Track (RM)	Winch (RM)	Assembly (RM)	Comm. (RM)	Total (RM)
1	Geliga Slipway 1 (1983)	159,950	54,840	319,900	434,150	388,450	100,540	82,260	1,540,090
2	Geliga Slipway 2 (1983)	191,940	68,550	457,000	502,700	411,300	127,960	114,250	1,873,700
3	Geliga Slipway 3 (1983)	228,500	82,260	491,275	731,200	479,850	159,950	123,390	2,296,425
4	Muhibbah Engineering (1990)	389,350	149,750	658,900	1,141,502	658,900	269,550	197,670	3,465,622
5	Sapor Engineering (1990)	778,940	492,597	838,600	2,836,974	898,847	572,385	521,430	6,939,773
6	University Kuala Lumpur (2002)	231,000	660,000	495,000	742,500	495,000	165,000	123,750	2,912,250
7	Sarawak Slipway (1985)	394,400	147,900	594,065	690,200	640,900	320,450	290,870	3,078,785
8	Prospect Dockyard (1990)	167,720	71,880	359,400	419,300	299,500	119,800	89,850	1,527,450
9	Tok Bali Dockyard (2000)	316,000	94,800	711,000	790,000	711,000	237,000	181,700	3,041,500