A METHOD FOR
MARINE CADASTRAL INFORMATION DISSEMINATION

NOOR ANIM ZANARIAH BINTI YAHAYA

UNIVERSITI TEKNOLOGI MALAYSIA

A METHOD FOR MARINE CADASTRAL INFORMATION DISSEMINATION

NOOR ANIM ZANARIAH BINTI YAHAYA

A thesis submitted in fulfilment of the
requirements for the award of the degree of
Master of Science (Geomatic Engineering)

Faculty of Geoinformation and Real Estate
Universiti Teknologi Malaysia

AUGUST 2012

The following publications have resulted from this research:

Noor Anim Zanariah Y., Abdullah Hisam O., Nazirah M.A. (2009), *New Approach of Marine Cadastre in Peninsular Malaysia*, East Asia Hydrographic Symposium, Kuala Lumpur, 20-22 October 2009.

Noor Anim Zanariah Y., Abdullah Hisam O., Nazirah M.A. (2009), *Marine Cadastre–Malaysia's Initiatives*, International Symposium and Exhibition on Geoinformation 2009 (ISG 2009), Kuala Lumpur, 10-11 August 2009.

To my beloved mother and father,

thank you for your prayers, sacrificial love and always believe in me.

I love you.

ACKNOWLEDGEMENT

First and above all, I praise God, the almighty for providing me this opportunity and granting me the capability to proceed successfully. This thesis appears in its current form due to the assistance and guidance of several people. I would therefore like to offer my sincere thanks to all of them.

Foremost, my appreciation and thanks goes to my supervisors, Dr. Abdullah Hisam bin Omar for his generous support, guidance, expertise, kindness, and most of all, for his patience. Thank you, Dr.

My special thanks to all the staffs from Department of Geomatics Engineering who had supported me in various areas of this research work. Thank you so much for all their help, support, interest and valuable hints. I also wish to express my special thanks to Puan Nazirah binti Mohamad Abdullah for her advices and her friendly assistance with various problems all the time regarding this thesis.

This thesis is completed with prayers and sacrificial love of my family, who always believed in me, stood beside me and encouraged me constantly, Mak, Abah, Along, Padil and Ana, thanks a million. For Aina, Jannah, Azira, Farah, Fadzlina, Hilmi, Noorsiah, Rabieah, Siti Kamariah, Ikbar, Azhan, Ibrahim and Helmi, thank you friends, for all those continuous support towards completing this thesis.

Lastly, I would thank Ministry of Higher Education (MOHE) Malaysia for the financial assistance, Skim Latihan Akademik Bumiputera (SLAB).

ABSTRACT

As one of the maritime nations, development in Malaysia not only takes place on the land but also extends to the marine area. In addition, technology advancement has influenced and changed the surveying industry and global mapping. Through preliminary research regarding marine cadastre, the framework for Marine Cadastre Processing System has been produced with ability to process data from the fieldwork, to compute and to adjust the information regarding marine areas. The purpose of this study is to facilitate the sharing and dissemination of Marine Cadastral information as well as an initiative to develop an online web-based GIS application. In this study, the architecture of the framework for Marine Cadastre Processing System was implemented as a means to process the data from Marine Cadastre demarcation. Moreover, this system has the capability to access the Marine Cadastre data via internet and its efficiency has been given emphasis using ArcGIS Server version 9.3. The development of Marine Cadastre geospatial database has been executed to support the system. Testing carried out using the same workstation as the server indicates that the system is fully functional to process the data and be accessed by the users via internet. The potential to disseminate and share the Marine Cadastral information has been successfully proved and the study can act as one of the initiatives for our country especially in the field of Marine Cadastre.

ABSTRAK

Sebagai salah satu negara maritim, pembangunan di Malaysia bukan sahaja berlaku di kawasan daratan tetapi juga meliputi kawasan marin. Di samping itu, kemajuan teknologi telah mempengaruhi dan mengubah industri ukur dan pemetaan global. Melalui penyelidikan awal mengenai kadaster marin, satu rangka kerja bagi menghasilkan Sistem Pemprosesan Kadaster Marin telah dihasilkan dengan keupayaan untuk memproses data dari kerja lapangan, mengira dan melaraskan maklumat berkaitan kawasan marin. Tujuan kajian ini adalah untuk memudahkan perkongsian dan penyebaran maklumat Kadaster Marin serta sebagai satu inisiatif untuk membangunkan aplikasi GIS dalam talian berasaskan web. Dalam kajian ini, seni bina rangka kerja bagi pembangunan Sistem Pemprosesan Kadaster Marin telah dilaksanakan sebagai satu cara untuk memproses data dari penandaan Kadaster Marin. Selain itu, sistem ini mempunyai keupayaan untuk mengakses data Kadaster Marin melalui internet dan kecekapannya telah diberi tumpuan menggunakan *ArcGIS Server* versi 9.3. Pembangunan pangkalan data geospatial Kadaster Marin telah dilaksanakan bagi menyokong sistem ini. Ujian yang dilakukan menggunakan stesenkerja yang sama sebagai pelayan *(server)*, telah menunjukkan bahawa sistem ini berfungsi sepenuhnya untuk memproses data dan diakses oleh para pengguna melalui internet. Potensi untuk menyebarkan dan perkongsian maklumat Kadaster Marin telah berjaya dibuktikan dan kajian ini boleh bertindak sebagai salah satu daripada inisiatif untuk negara kita terutamanya dalam bidang Kadaster Marin.

TABLE OF CONTENTS

CHAPTER	TITLE		PAGE
	THESIS STATUS DECLARATION		
	SUPERVISOR DECLARATION		
	TITLE PAGE		
	DECLARATION		ii
	DEDICATION		iii
	ACKNOWLEDGEMENT		iv
	ABSTRACT		v
	ABSTRAK		vi
	TABLE OF CONTENTS		vii
	LIST OF TABLES		xi
	LIST OF FIGURES		xii
	LIST OF ABBREVIATIONS		xvi
	LIST OF APPENDICES		xviii
1	**INTRODUCTION**		
	1.1	Background of the Research	1
	1.2	Problem Statement	4
	1.3	Research Objectives	5
	1.4	Research Scope	5
	1.5	Significant of the Research	7
	1.6	Thesis Outline	8

2	**INTRODUCTION OF MARINE CADASTRAL SYSTEM**		
	2.1	Introduction	11
	2.2	Concept of Malaysian Cadastral System	11
	2.3	The Effects of Land Administration Trends and Cadastral Reforms in Malaysia	14
	2.4	Future Cadastre (Cadastre 2014)	16
	2.5	Introduction of Marine Cadastre System	18
	2.6	Marine Environment in Malaysia	21
	2.7	Conclusion	28
3	**MARINE CADASTRAL ACCESS AND DISSEMINATION**		
	3.1	Introduction	30
	3.2	Introduction of Geographic Information Systems (GIS)	31
		3.2.1 Geospatial Database (Geodatabase)	34
	3.3	Web-Based GIS	36
		3.3.1 Types of Web-based GIS Application	39
		3.3.2 Component of Web-based GIS	40
	3.4	Component of ArcGIS Server Version 9.3	42
	3.5	Land Administration and Information Dissemination	44
	3.6	Marine Cadastre Information System	47
4	**DEVELOPMENT OF MARINE CADASTRE GEOSPATIAL DATABASE COMPONENT**		
	4.1	Introduction	57
	4.2	Data Planning and Preparation Phase	58
	4.3	Preliminary Study	59
	4.4	Data Acquisition	60
		4.4.1 Data Planning	60

		4.4.2 Dynamic Delineation (Marine Cadastre Boundary Mark Demarcation)	63
	4.5	Data Processing	64
	4.6	Data Editing	65
	4.7	Design and Development Phase	66
		4.7.1 Conceptual Design of the Database	67
		4.7.2 Logical Design of the Database	68
		4.7.3 Physical Design of the Database	69
		4.7.4 Geodatabase Development	71
5	**DEVELOPMENT OF WEB-BASED GIS COMPONENT FOR MARINE CADASTRE PROCESSING SYSTEM**		
	5.1	Introduction	75
	5.2	WebGIS Map Development	76
		5.2.1 Web-based Manager	77
		5.2.2 Web Applications	79
	5.3	Web Page User Interface Development	87
	5.4	Supported Clients	89
6	**SYSTEM TESTING AND VALIDATION**		
	6.1	Introduction	90
	6.2	Data Acquisition and Processing	91
	6.3	Marine Cadastre Geodatabase	93
	6.4	Development Of Web-Based Application	96
		6.4.1 Web Page User Interface	96
		6.4.2 Interactive Web Map Interface	98
	6.5	System Testing	102
		6.5.1 Interactive Web Map Navigation Tools Testing	102
		6.5.2 Interactive Web Map Task Testing	104
		6.5.3 Testing on the System's Processing Method	108

6.6 The Architecture of Framework for Marine Cadastre Processing System 114

7 CONCLUSION AND RECOMMENDATION 116

REFERENCES 118

Appendices A - H 126 - 134

LIST OF TABLES

TABLE NO.	TITLE	PAGE
2.1	Malaysian Maritime Zone (Nazery Khalid, 2005)	23
3.1	The comparison of the three types of Geodatabases (ESRI, 2010c)	37
3.2	Categories of web-based GIS application (Rinner, 1998)	40
3.3(a)	Status of Marine Cadastre in Various Countries	55
3.3(b)	Status of Marine Cadastre in Various Countries	56
4.1	List of Pre-computation Coordinates	61
4.2	Adjusted WGS84 Coordinate for Control Stations	62
4.3	Comparison of Marine Boundary Marks Location between Pre-Computation and Surveyed	64
4.4	Comparison of Pre-computation Area and Surveyed Area	65
6.1	Surveyed Coordinates of Marine Cadastre's boundary marks	91
6.2(a)	Master Data List for Marine Cadastre Database	94
6.2(b)	Master Data List for Marine Cadastre Database	95
6.3	Feature Classes in Each one of Feature Dataset	95
6.4	Tools contain in Toolbar	101

LIST OF FIGURES

FIGURE NO.	TITLE	PAGE
1.1	Geodatabase Development Processes (Fischer and Nijkamp, 1993)	7
1.2	Workflow of the study	10
2.1	Cadastral Concept Diagram (FIG, 1995)	12
2.2	Evolution of people to land relationship (Ting *et al.,* 1999)	14
2.3	Evolution of Western Cadastral System (Ting *et al.,* 1999)	15
2.4	The workflow of Malaysian's *e*Kadastre (Hasan, 2009)	16
2.5	Marine cadastre concept diagram (Binns *et al*., 2004)	21
2.6	Malaysian Maritime Boundary: Sheet 1 (Teo and Ahmad Fauzi, 2006)	22
2.7	Malaysian Maritime Boundary: Sheet 2 (Teo and Ahmad Fauzi, 2006)	22
2.8	3D Perspective of Marine Rights (Hua, 2006)	25
2.9	Maritime Zones (Ahmad Fauzi, 2006)	26
2.10	Marine Cadastre System Conceptual model of Peninsular Malaysia (Ashraf, 2004)	27
3.1	Part of a GIS, (Zeiler, 1999)	31
3.2	Webmapping System Architecture (Horanont et al., 2002)	39
3.3	ArcGISServer System Architecture (ESRI, 2009a)	43

3.4	Establishment of Computerised Systems by Some Land Related Agencies (Fauziah et al., 2010)	45
3.5	MyGDI, a Geospatial Information Portal (ESRI Malaysia, 2012)	46
3.6	Hypothetical View of Coastal and Marine Information System (Sutherland, 2005)	48
3.7	Ocean Planning Information System (OPIS): Using the OPIS Internet mapping application (Fowler and Treml, 2001)	49
3.8	MMC National Web-Viewer (OSG, 1999)	51
3.9	Screen Capture of Musquash MPA CARIS Spatial Fusion Application (Ng'ang'a et al, 2001)	53
3.10	One of the Applications of MarZone (Collier et al., 2002)	54
4.1	The chart of Data Planning and Preparation Phase (Phase I)	58
4.2	Pre-computation Plan of Case Study Area	61
4.3	The Virtual RINEX for Station 59 and Station 60	62
4.4	Buoy Locations	63
4.5	Diagram of the Buoy	63
4.6	Surveyed Area	65
4.7	Physical Model of the Data Editing Process	66
4.8	GIS Development Phases	67
4.9	Surveyed Data from the Field Work	69
4.10	Digitized Data from Nautical Chart of Johor Strait West	70
4.11	Flow Chart of Data Editing	71
5.1	The local directory in this study server *(C:\master)*	77
5.2	ArcGIS Server Manager *(Log-in box)*	78
5.3	ArcGIS Server Manager *(Home)*	79
5.4	Workflow of creating web application ArcGIS Server	80

5.5	*"Add new service"* command in ArcGIS Server Manager	80
5.6	Process for adding new service in GIS resource.	82
5.7	Name of the application	83
5.8	Connection with GIS server (URL)	83
5.9	Layers chosen in the Web Application.	84
5.10	Task included in the Web Application	85
5.11	*Page Properties* and *Application Setting* tabs	86
5.12	List of map elements	86
5.13	Final panel of the wizard appears	87
5.14	Concept of web page interface	88
5.15	Web page user interface developed by HTML editor	89
6.1	Certified Plan (CP) of Marine Cadastre Lot	92
6.2	Digitized data used as spatial data in this study	93
6.3	Web Page Interface Environment	97
6.4	Marine Cadastre Processing System Web Map Interface	98
6.5	Legend of Developed Web Map Interface	99
6.6	Task of Developed Web Map	100
6.7	Display of the Result Pane	100
6.8	Functionality of Zoom-in Window and its Result	103
6.9	Navigation Scale	103
6.10	Identify task	104
6.11	Query Attributes	105
6.12	Search Attributes and the *'Zoom To Selected Features'* Function	106
6.13	Distance between two points of the created line	107
6.14	Buffer Function within 25 metres	107
6.15	*Data Submission* link	108
6.16	Adjusted Data using Star*Net	109
6.17	Exported Data for editing in AutoCADD	109
6.18	Converted Coordinates in GDTS	110
6.19	Steps to transform adjusted coordinates	111

6.20	Directory of the Marine Cadastre's fieldwork	112
6.21	Process of updating boundary points of Marine Cadastre's Lot	112
6.22	Process of updating the attributes of Marine Cadastre's Lot	113
6.23	Overview of the Framework	114
6.24	Architecture Framework for Marine Cadastre Processing System	115

LIST OF ABBREVIATIONS

AOR	–	Agency of Responsibility
API	–	Application Programming Interfaces
CAD	–	Computer-Aided Design
CALS	–	Computer Assisted Land Survey
CARIS	–	Computer Aided Resource Information System
CCS	–	Coordinated Cadastral System
CGDI	–	Canadian Geospatial Data Infrastructure
CGI	–	Common Gateway Interface
CP	–	Certified Plan
DBMS	–	Database Management System
DCDB	–	Digital Cadastral Data Base
DSMM	–	Department of Survey and Mapping Malaysia
ECDIS	–	Electronic Charting Display Information Systems
EEZ	–	Exclusive Economic Zone
ERM	–	Entity-Relationship Model
ESRI	–	Environmental Systems Research Institute
FIG	–	International Federation of Surveyors
GB	–	Gigabyte
GIS	–	Geographic Information Systems or popularly known
GPS	–	Global Positioning System
HTML	–	HyperText Markup Language
HTTP	–	Hypertext Transfer Protocol
ICT	–	Information and Communication Technology
IIS	–	Internet Information Server
MaCGDI	–	Malaysian Centre for Geospatial Data Infrastructure

MGDI	–	Marine Geospatial Data Infrastructure
MMC	–	Multipurpose Marine Cadastre
MMS	–	Minerals Management Service
MyGDI	–	Malaysia Geospatial Data Infrastructure
NaLIS	–	National Infrastructure for Land Information System
nm	–	nautical miles
NOAA	–	National Oceanic and Atmospheric Administration
NRE	–	Natural Resources and Environment
OPIS	–	Ocean Planning Information System
PCGIAP	–	Permanent Committee on GIS Infrastructure for Asia and the Pacific
PDA	–	Personal Digital Assisstant
PHP	–	HyperText Preprocessor
SOC	–	Server Object Container
SOM	–	Server Object Manager
SQL	–	Structured Query Language
TIN	–	Triangulated Irregular Network
UNCLOS	–	United Nations Convention on the Law of the Sea
WebGIS	–	Web-based Geographic Information Systems

LIST OF APPENDICES

APPENDIX	TITLE	PAGE
A	Home of the Webpage	126
B	Webpage Display of Background (Marine Cadastre in General)	127
C	Webpage Display of Background (Marine Cadastre in Malaysia)	128
D	Webpage Display of Background (Marine Cadastre Geodatabase)	129
E	Webpage Display of Data Submission	130
F	Webpage Display of About Us	131
G	Webpage Display of Contact Us	132
H	Webpage Display of Link	133

CHAPTER 1

INTRODUCTION

1.1 Background of the Research

Approximately, seventy percent of the earth's surface is water-covered, and the oceans hold about ninety-six percent of all Earth's water. From time immemorial, the oceans surrounding the marine provinces played a significant role in the defence, economic, and political matters of the state concerned. Based on the geographical shape of Malaysia, which covers with two primary landmasses, Peninsular Malaysia and East Malaysia, is endowed with a large maritime realm covering sea areas of about 515,000 square kilometres, and a coastline of approximately 4,576 kilometres in length (Ahmad Fauzi, 2004).

As one of the marine provinces, the development in this country not only takes place on the land but also extends to the coastal and offshore areas. Malaysia's vast coastal and oceanic resources are priceless since ancient times, from limited to fishing and navigation activities, its marine resources are evolved to a wide spectrum of various areas such as trade, energy resources, transportation, employment, food source, leisure, tourism and security.

The management of resources within Malaysia's maritime has been governed by many different stakeholders and regulated by a plethora of acts either nationally, or internationally. Since October 1996, the government of Malaysia has been ratified the United Nations Convention on the Law of the Sea (UNCLOS), in order to improve the management of the seas and its resources (Juita, 1997). It establishes a jurisdictional regime under which Malaysia; itself may claim, manage and utilize its maritime territories (UN, 1982). In line with provisions of UNCLOS, Malaysia is entitled to claim the boundary of its territorial sea, contiguous zone and Exclusive Economic Zone (EEZ). As Malaysia has enacted several acts, governed by different stakeholders, a number of complex relationships and interactions between overlapping and competing in rights, restrictions and responsibilities have occurred among various stakeholders especially regarding marine boundary's issue.

On the contrary, the method applied on terrestrial (land) to manage, administer and state the rights, restrictions and responsibilities using legislative system in Malaysia, called Land Cadastre System. The concept of a land-based cadastre has existed for many years. Unfortunately, execution of this system is not applicable especially when we are dealing with tenure in water area or ocean. In this point of fact, the issue of how to give a hold to a particular individual in the marine area, answered with the introduction of Marine Cadastre System. The term cadastre has not often been used in the context of the marine environment. There are many similarities, but a few significant differences, between a marine and land cadastre.

Many of the upland cadastral components such as adjudication, survey, and owner rights have a parallel condition in the ocean. These boundaries share a common element with their land-based counterparts in that in order to map a boundary, one must adequately interpret the language of the law and its spatial context. Other typical cadastral processes such as demarcation become problematic when applied to marine boundaries. Marine boundaries are delimited, not demarcated, and generally there is no physical evidence, only mathematical evidence left behind (Carrera, 1999).

In 2002, within the project entitled, *"Defining and Developing a Marine Cadastre for Australia"*, Marine Cadastre System is explained as defined boundaries and its limitations, related rights and restrictions in the marine area which are legally describes, visualizes and realizes by a spatial boundary management tool for equipping the data to be more effectively managed, administered and assessed. (Binns *et al.,* 2003).

As been recognized, the introduction of Marine Cadastre in Malaysia is comparatively new compared to other country and many researches have been done regarding this issue, worldwide (Noor Anim *et al.,* 2009b). Canada and Australia are the perfect example of active countries leading in Marine Cadastre's field. Although, Malaysia is known as littoral nation, there was none implementation of Marine Cadastre in our marine environment. With the growth of development, various issues concerning with marine area must need a full consideration in administration, jurisdiction, management level for rights, restrictions and responsibilities within this area.

Recently, there has been a surge consciousness of the significance of Geographic Information Systems or popularly known as GIS in all over the world. GIS has been developed since the evolution of technology like microprocessor has discovered. GIS defined as a system based on information from computer that aims to add, manipulate, store, analyze and display the related and referenced and associated tabular attribute data spatially, in order to solve management problems and complex research (Fischer and Nijkamp, 1993).

As predicted, the advancement of the Internet and web became a major method to access the GIS. The development of web-based GIS has been a new phenomenon after the three decades' existence of GIS. Most of the Geographic Information Systems (GIS) demands have been customized from desktop GIS to web-based GIS (Chang and Park, 2004). The development of web-based Geographic Information Systems (WebGIS), with no application of desktop GIS, allows the user

to create, publish and perform the geospatial data analysis via Internet. When this technology combines with Internet, GIS software is an unnecessary requirement for a user. In addition, web-based GIS's biggest advantage is a timesaving for data sharing and spatial searching compared to earlier desktop GIS software. On the other hand, a web map is a web-based service on the Internet able to generate a map using the information data from database called *georeferenced map images* by a map server. Web maps have become more popular due to their convenience low cost, and dynamic characteristic (Kraak, 2001).

Currently in land-based environment, the dissemination of information is supported by several infrastructures and portals developed by Malaysian government, for instance, Malaysia Geospatial Data Infrastructure (MyGDI) and Department of Survey and Mapping, Malaysia (DSMM) GeoPortal. Through the preliminary research of Marine Cadastre, comparisons with other country initiatives, the technology in web-based GIS and several reviews related to existence of land or marine information system, the method for Marine Cadastral information dissemination can be accomplished.

1.2 Problem Statement

There is an increasing realisation that the interests of a nation do not stop at the land-sea interface (Collier et al. 2001). The economic, environmental and social impacts are just beginning to be felt, with the competition within the marine environment resources. Besides, the development in coastal and marine area became more popular with highly demand from certain stakeholders especially from the construction of resorts, marina residences, harbours, and recreational parks. This has given rise to the need for more efficient and effective maritime boundary management techniques, such as a marine cadastre, to be put in place within Malaysia's maritime jurisdiction.

Furthermore, the system that have a capability to manage and process a Marine Cadastre's survey are not been introduced yet. The dissemination of Marine Cadastral information to users via internet will perform as an initiative to share and exchange the geospatial information within marine area.

1.3 Research Objectives

Several objectives have been identified to fulfil the research's requirement. The objectives are as follows:

(1) To implement the architecture of the framework for Marine Cadastre Processing System.
(2) To develop online web base application.
(3) To analyse the efficiency of Marine Cadastral dissemination via internet.

1.4 Research Scope

In order to achieve the research objectives, the scope of work, involved all the procedures based on the objectives. There are:

1st Objective : To implement the architecture of the framework for Marine Cadastre Processing System

Scope **:**

- Review of the conceptual model in Marine Cadastre.
- Review on current effort on Marine Cadastre and related projects, worldwide.
- Issues in developing Marine Cadastre System.
- Case Study: Nusajaya, Iskandar Development Region, Johor**.**
- Initial design of the architecture of the framework for Marine Cadastre Processing System
- Planning of data acquisition such as;
  - Field work on dynamic delineation (Marine Cadastre)
  - Previous field work
  - Lot Information
  - Plan and Nautical Chart

2nd Objective: To develop online web base application

Scope **:**

- The system architecture is designed and developed with assistance of GIS software.
- The development of Geospatial Database will be executed based on the understanding of elements in Figure 1.1**,** using ArcGIS Desktop software.
- The development of online web base application using ArcGIS Server.
- The development of Star*net link for adjustment module.
- The development of web page for user interface for web map view.

3rd Objective: To analyse the efficiency of Marine Cadastral dissemination via internet.

Scope **:**

- The system will be analyzed its efficiency included with accessibility, functionality and its processing result via internet.

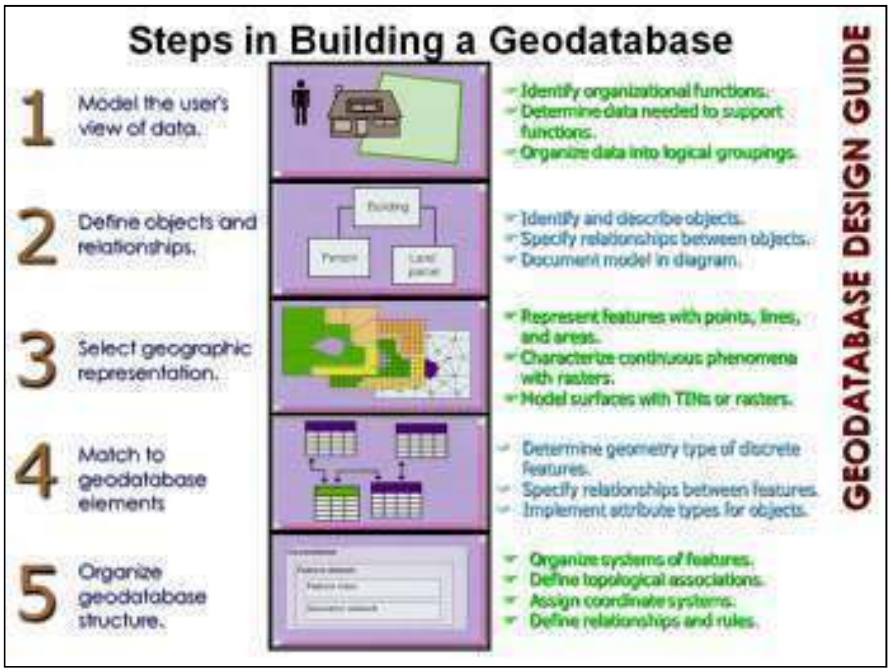

Figure 1.1 Geodatabase Development Processes
(Fischer and Nijkamp, 1993)

1.5 Significant of the Research

The significances of the study include:-

(1) As an initiative to form a system for the purpose of facilitating the sharing and dissemination of geospatial information within marine area.

(2) To develop a management and processing system for Marine Cadastre that will produce a mechanism with ability to manipulate data from field when Marine Cadastre' boundaries has been demark.

(3) The system not only facilitates online access to marine information but also able to compute and adjust the information for user via web

(4) As we dealing with marine environment, a model of Marine Cadastre Processing System will be developed within case study area.

Once completed, this system will have the ability of property's visualisation of rights, restrictions, regulations, and administration governance. Besides, the system will helped the policy makers in understanding the argument, revealing the variation in national or state policy. Moreover, the system able to educate the public on justifying boundary limits and providing a general organizing structure to very complex data. The system hopefully, will help Malaysia's authority to manage, control and administer the associated laws, restrictions, limitations and responsibilities in marine environment. It provides a base for geospatial data exploration, evaluation, and application for users and data providers within all levels of government, commercial, and non-profit sectors as well as the academia and the public.

1.6 Thesis Outline

This thesis is arranged in seven chapters. Chapter 1 of the thesis introduces the background, problem statements and the objectives of the research. The scopes as well as approach that have been utilized in undertaking the research are also reviewed.

Then, there are two-background chapters; Chapter 2 reviews the background of the terrestrial (land) cadastre and marine environment worldwide. The developments of land cadastre from its definition, roles, rights, restrictions, responsibilities to the introduction of Marine Cadastre are discusses as well as Malaysian marine environment and activities.

Chapter 3 gives a background introduction of Geographic Information Systems (GIS) and Web-based GIS as the tools to disseminate and gain access in digital form. This chapter also aims to identify all the reviews on marine management and the initiatives from other countries, which already implemented the Marine Cadastre.

Chapter 4 presents the development process of Marine Cadastre Geodatabase. Based on Figure 1.2, this chapter covers the process from Phase I: Data Planning and Preparation Phase. The first phase focuses on the process of obtaining data spatial. Literature review and needs assessment regarding the study have been done before the particular data is obtained. After data processing phase, the data is edited for the process of building geodatabase. Then, the second phase, the Development of Marine Cadastre Geodatabase will take place in the same chapter.

Move on to Chapter 5, this chapter highlights on Phase III, specifically for designing and developing the web-based GIS component of the system. The implementation of ArcGIS Server and other software are also discussed (Figure 1.2).

Chapter 6 deals with the testing and validation of the research. This provides the result of the marine cadastre survey's data and the application of geodatabase and webGIS of the Marine Cadastre Processing System. The system testing also includes observing either the system meets the objective of online information dissemination or not.

Chapter 7 concludes the thesis, summing up the results and describing the possible direction for future research.

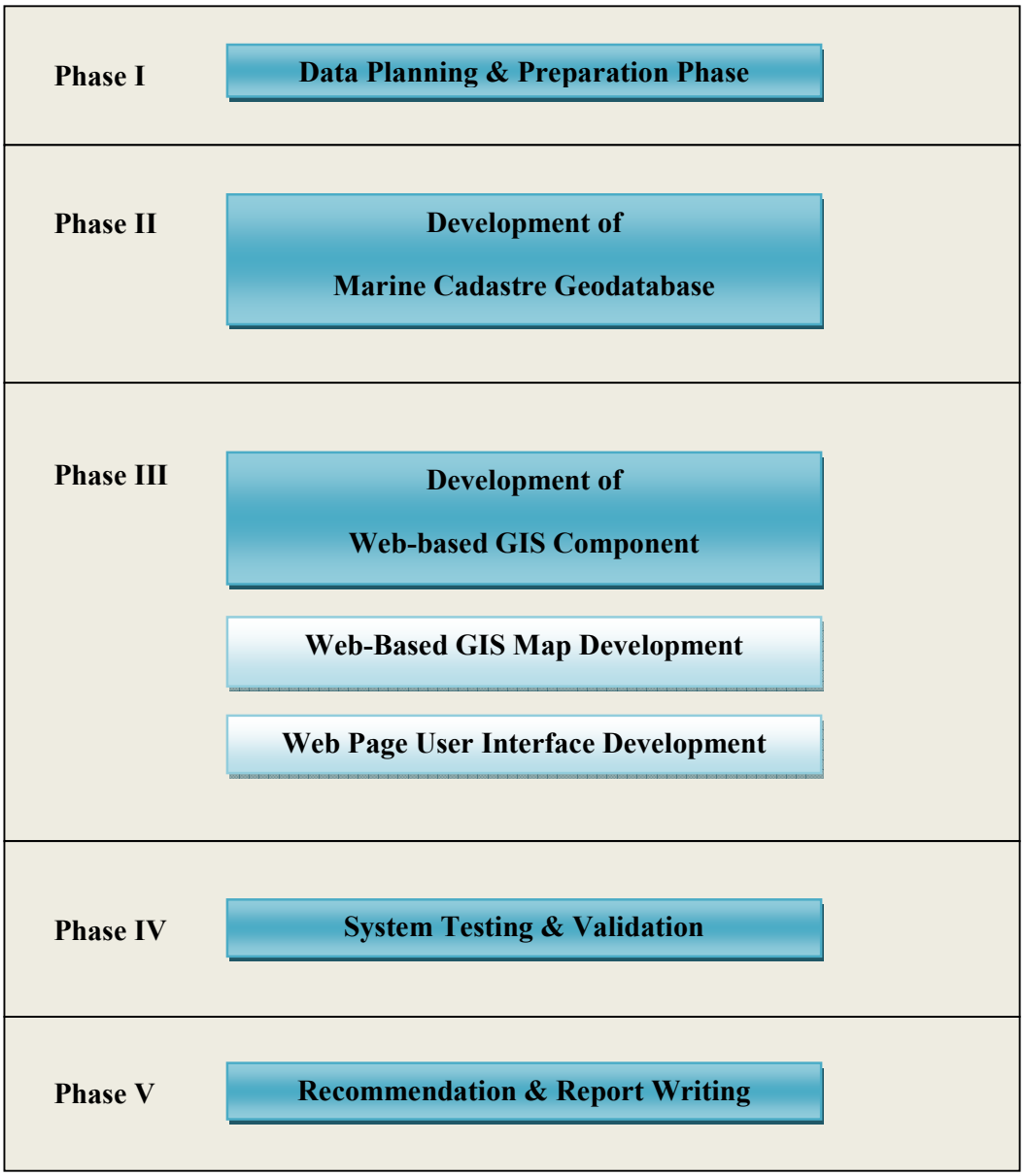

Figure 1.2 Workflow of the study

REFERENCES

Abdullah Hisam bin Omar, Abd. Majid bin Abd. Kadir, Teng, C. B., Megat Khairun bin Buang (2006) *Development of Automated Cadastral Database Selection and Visualization System to Support the Realization of Modern Cadastrate in Malaysia*. Project Report. Unpublished note. Faculty of Geoinformation Science and Engineering, Skudai, Johor.

Abdul Majid bin Mohamed, Tong, C.W. and Seok, C. H. (1998). *Cadastral Reforms in Malaysia*. FIG XXI Congress Proceeding, Commission 7, Brighton.

Abd Majid Bin A Kadir and Abdullah Hisam Bin Omar (2004). *Methodology for the Development of National Digital Cadastral Database (NDCDB).* Unpublished note. Kursus Coordinated Cadastral System (CCS). Institut Tanah & Ukur Negara, Perak

Abdul Rahman, Janib and Wong (1997). *The Maritime Sector and the Malaysian Economy,* MIMA Monograph, p. 16.

Ahmad Fauzi bin Nordin (2006), *Country Report on Administering the Marine Environment*, PCGIAP Working Group 3: Kuala Lumpur's International Workshop, May 04-07, 2004.

Ahmad Fauzi bin Nordin (2010), *Country Report on a Worldwide Comparison of Cadastral Systems*, PCGIAP Working Group 3: Okinawa's International Workshop, July 12-13, 2003.

Al-Sabhan, W., Mulligan, M. and Blackburn, G.A. (2003). A real-time hydrological model for flood prediction using GIS and the WWW. *Computer, Environment and Urban Systems. Volume 27 (Issues 9–32), Elsevier Ltd.*

Ashraf bin Abdullah (2004). *Pengkonseptualan Sistem Maklumat Kadaster Marin Bagi Semenanjung Malaysia*. Master's Thesis, Universiti Teknologi Malaysia, Skudai, Malaysia.

Azemi Bin Kasim (2012). *Review of the National Land Code 1965 (Consultation Paper).* Department of the Director General of Lands and Mines. Retrieved on February 8, 2012, from http://www.kptg.gov.my/sources/publication/research-a-development.html

Bartlett, D., Longhorn R. and Garriga, M.C. (2004). Marine and Coastal Data Infrastructures: a Missing Piece in the SDI Puzzle. *7th Global Spatial Data Infrastructure Conference*, 2-6 February 2004, Bangalore, India.

Binns, A., Rajabifard, A., Collier, P. and Williamson, I.P. (2003). Issues in Defining the Concept of a Marine Cadastre for Australia. *UNB-FIG Meeting on Marine Cadastre Issues*.15-16 September 2003. University of New Brunswick, Canada.

Binns, A., Rajabifard, A., Collier, P. and Williamson, I.P. (2004). *Issues In Developing Marine SDI***,** Centre for Spatial Data Infrastructures and Land Administration Department of Geomatics, The University of Melbourne, Australia

Carrera, G. (1999). *Lecture notes on Maritime Boundary Delimitation*, University of Durham, U.K. July 12-15, 1999.

Chan, T. O. and Williamson, I. (1999). The different identities of GIS and GIS diffusion, *International Journal of Geographical Information Science*, 13(3).

Chang, Y.S. and Park, H.D. (2004). Development of Web-based Geographic Information System for the Management of Borehole and Geological Data. *Journal of Computers & Geosciences*, Volume 30, Issue 8, ScienceDirect.

Cheung, R. L., and Brown, S. C. (2001). Designing a distributed geographic information System for environmental education, *Proceedings of the 21st Annual ESRI International User Conference*, San Diego, CA.

Collier, P.A., Leahy F.J. and Williamson I.P. (2001). *Defining A Marine Cadastre For Australia*, A Spatial Odyssey: 42nd Australian Surveyors Congress. Brisbane, Australia.

Collier, P. A., Murphy, B. A., Mitchell, D. J. and Leahy, F. J. (2002). The Automated Delimitation of Maritime Boundaries - An Australian Perspective. *Marine Geodesy,* April. NOAA Coastal Services Center. USA

.

Daryl B., Debra A.H. (2006). *Mastering ArcGIS*, 2nd Ed, Avenue of Americas, New York, McGraw-Hill Companies.

ESRI (2009a). *ArcGIS Server HELP*. 380 New York Street, Redlands, CA 92373-8100, USA.

ESRI (2009b). *What is GIS?* Retrieved on May 28, 2009, from http://www.gis.com/whatisgis/index.html

ESRI (2010a). *ArcGIS Server: Overview*. Retrieved on November 16, 2010, from http://www.esri.com/software/arcgis/arcgisserver/index.html

ESRI (2010b). *GIS Dictionary*. Retrieved on January 18, 2010, from http://support.esri.com/en/knowledgebase/GISDictionary/term/geodatabase

ESRI (2010c). *ArcGIS Server 9.3.1 Help.* Retrieved on February 23, 2010, from http://webhelp.esri.com/arcgisserver/9.3.1/dotNet/index.htm#geodatabases/types_of_geodatabases.htm

ESRI Malaysia (2012). *Case Studies: Malaysian Centre for Geospatial Data Infrastructure (MaCGDI).* Retrieved on February 23, 2012, from http://www.esrimalaysia.com.my/news/Case%20Study/Malaysia_case%20study_My%20GDI_2012.pdf

FIG (1995). *FIG Statement on the Cadastre*. Report prepared for the International Federation of Surveyors by Comission 7 (Cadastre and Land Management). Retrieved on November 10, 2008, from http//www.fig7.org.uk/

Fischer, M. and Nijkamp, P. (1993). *Spatial Modeling and Policy Evaluation* Geographic Information Systems, Springer-Verlag, Berlin.

Fowler C. and Treml E. (2001), *Building A Marine Cadastral Information System For The United States*. International Journal on Computers, Environment & Urban Systems Special Issues: Cadastral Systems.

Fuziah Binti Abu Hanifah (2008). Malaysian Geospatial Data Infrastructure (MyGDI) - The Way Forward. *3rd National GIS Conference and Exhibition: Enhancing The Delivery System Using Technology Government Geoinformation.* July 21-22, 2008. PWTC KL, Malaysia.

Fuziah binti Abu Hanifah, Zainal bin A. Majeed, Hamdan bin Abd Aziz, Jawahiril Kamaliah binti Mohamad, Mariyam binti Mohamad, Norizam binti Che Noh, Anual bin Aziz, Hazri bin Hassan, Yaacub bin Yusof, Abd. Majid bin A. Kadir, Abdullah Hisam bin Omar, Ghazali bin Desa (2010). *MyGDI: The Enabling Platform Towards Spatially Enabled Government In Malaysia.* (1st Ed). Kuala Lumpur, Malaysia. Malaysian Centre for Geospatial Data Infrastructure (MaCGDI).

Gillespie, R., Butler, M., Anderson, N., Kucera, H. and LeBlanc, C. (2000). *MGDI: An Information Infrastructure to Support Integrated Coastal Management in Canada*, GeoCoast, 1 pp. 15-24, Retrieved on April 24, 2009, from http://www.theukcoastalzone.com/geocoast/Volume1/Gillespie.pdf

Hasan Bin Jamil (2009). Cadastral Reform In Malaysia To Support Spatially Enabled Government. *3rdland Administration Forum For The Asia And Pacific Region – Re-Engineering The Cadastre To Support E-Government.* May 24-26, 2009, Tehran, Iran

Horanont, T., Tripathi, N. K. and Raghavan, V. (2002). A Comparative Assessment of Internet GIS Server Systems. *Map Asia*, Hotel Shangri-La, August 7–9, 2002, Bangkok, Thailand.

Hua, T. C. (2006). *Isu-isu Pentadbiran Persekitaran Marin*. Unpublished note, Department of Survey and Mapping, Malaysia.

Juita R. (1997). Malaysia and The Law of the Sea: A Harvest of Riches, *Maritime Institute of Malaysia (MIMA) Bulletin,* Volume 4 (No.1), p.15

Kaufmann, J. (2002). Cadastre 2014: A Vision For A Future Cadastral System. *Presented at the 1st Congress on Cadastre in the European Union*, May 15 – 17, 2002, Granada, Spain

Kaufmann, J. and Steudler, D. (1998). *Cadastre 2014: A Vision for A Future Cadastral System*. Working Group 7.1 FIG Commission 7, The XXI FIG Congress in Brighton, UK.

Kraak, M.J. (2001). Setting and Needs for Web Cartogrphy. In M.J. Kraak & A. Brown (Eds.), *Web Cartography: Development and Prospectus* (pp. 1-7). London: Taylor & Francis.

Longley, P.A., Goodchild, M.F., Maguire, D.J. and Rhind, D.W. (2001). *Geographic Information Systems and Science*, Chichester: John Wiley & Sons, Ltd.

MMS (2006). *Implementation Plan for the Multipurpose Marine Cadastre.* OCS Mapping Initiative: Energy Policy Act of 2005. United States Department of the Interior, USA

Nazirah Mohd. Abdullah (2010). *Pengkonseptualan Sistem Maklumat Kadaster Marin Bagi Semenanjung Malaysia*. Master's Thesis, Universiti Teknologi Malaysia, Skudai, Malaysia.

Nazery, K. (2005). Maritime Economic Activities: Planning Towards Sustainable Development. *Paper presented at the Research Workshop on Environment and Rural Poverty: Linking Resources Use, Governance & Sustainable Policies. Organized by Institute for Environment and Development (LESTARI)*, February 22, 2005. Universiti Kebangsaan Malaysia.

Neely, R. M., Treml, E., LaVoi, T. and Fowler, C. (1998), *Facilitating Integrated Regional Ocean Management Using a Web-based Geographic Information System*, Coastal Services Centre, National Oceanic and Atmospheric Administration, Retrieved on March 25, 2009, from http://www.csc.noaa.gov/opis/html/occ_98.htm

Ng'ang'a, S. M., M. Sutherland, S. Cockburn and S. Nichols (2004). *Toward a 3D marine cadastre in support of good ocean governance: A review of the technical framework requirements*. In Computer, Environment and Urban Systems, 28.

NOAA (1998), *Ocean Planning Information System Aim*, Ocean Planning Information System Homepage, Retrieved on April 16, 2009, from http://www.csc.noaa.gov/opis/

Noor Anim Zanariah Binti Yahaya, Abdullah Hisam bin Omar and Nazirah Mohd. Abdullah (2009a). New Approach of Marine Cadastre in Peninsular Malaysia, *East Asia Hydrographic Symposium*, October 20-22, 2009. Kuala Lumpur, Malaysia

Noor Anim Zanariah Binti Yahaya, Abdullah Hisam bin Omar and Nazirah Mohd. Abdullah (2009b). Marine Cadastre–Malaysia's Initiatives, *International Symposium and Exhibition on Geoinformation 2009 (ISG 2009)*. August 10-11, 2009. Kuala Lumpur, Malaysia.

OSG (1999). *Principles for a Seabed Cadastre*. Land Information. OSG Technical Report 9. Office of the Surveyor-General New Zealand,

Plewe, P. (1997). GIS Online: Information Retrieval, Mapping and the Internet. *OnWord Press,* Santa Fe, New Mexico.

Rinner, C. (1998). Online Maps in GeoMed – Internet Mapping, Online GIS and Their Application in Collaborative Spatial Decision-Making. *In Proceedings of GIS PlaNET'98. International Conference on Geographic Information.* Lisbon, Portugal.

Robertson, B., Benwell, G. and Hoogsteden, C. (1999), The Marine Resource: Administration Infrastructure Requirements, *UN-FIG Conference on Land Tenure and Cadastral Infrastructures for Sustainable Development*, Melbourne, Australia.

Srebro, H., Fabrikant, I. and Marom, O. (2010). Towards a Marine Cadastre in Israel. *FIG Congress 2010: Facing the Challenges – Building Capacity*. April 11-16, 2010. Sydney, Australia.

Sutherland, M. (2005). *The Marine Cadastre: Legal and Spatial Data Contribution to Economic, Environmental and Social Development*. TS 40 – FIG Commission 4 Working Group Activities, FIG Working Week and GSDI-8, April 16-21, 2005, Cairo, Egypt.

Taylor, C. and Stein, D (2011). *The Multipurpose Marine Cadastre*. Site Collection Documents of MMC Fact Sheet, Retrieved on May 16, 2011, from http://www.marinecadastre.gov

Teo, C. T. and Ahmad Fauzi bin Nordin (2006). A National Geocentric Datum and the Administration of Marine Spaces in Malaysia. *Administering Marine Spaces: International Issues.* FIG Publication No 36 (Chapter 4). The International Federation of Surveyors (FIG).

Ting, L., Williamson, I., Grant, D., and Parker, J. (1999). *Understanding the Evolution of Land Administration Systems in Some Common Law Countries*. Survey Review, 35(272), 83-102.

UN (1985). *Conventional and Digital Cadastral Mapping.* Report of the Meeting of the Ad Hoc Group of Experts on Cadastral Surveying and Land Information Systems. Economic and Social Council.

WCED (1987). United Nation World Commission on Environment and Development: Our Common Future (Brundtland's Report). *Oxford University Press*, p. 43

Williamson, I (2009). Re-engineering the cadastre to support e-government. *3rd UN sponsored Land Administration Forum for Asia and the Pacific Region*. May 24-26, 2009.Tehran, Iran.

Wright, D (2003). Advancing Web GIS "Beyond Mapping". *Pervasive Computing* Oregon State University.

Xue, Y., Cracknell, A.P., Guo, H.D., (2002). Telegeoprocessing: The integration of Remote Sensing, Geographic Information System (GIS), Global Positioning System (GPS) and Telecommunication, *Int. J. Remote Sensing*, 23(9): 1851-1893.

Yang, Y., Wilsona, L.T, Wanga, J., Lia, X. (2011). Development of an integrated Cropland and Soil Data Management system for cropping system applications. *ScienceDirect, Computers and Electronics in Agriculture.*Volume 76 (Issue March,1 2011), Pages 105-118.

Zeiler, M. (1999). *Modelling Our World – The ESRI Guide to Geodatabase Design*, California USA: ESRI Inc.