

DEVELOPMENT OF MARITIME RESCUE APPLICATION SYSTEM USING
GEOGRAPHIC INFORMATION SYSTEM APPROACH

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DEDICATION

Especially To:

My Family and beloved husband

Thanks for all your love and support

May God Bless

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ABSTRACT

Nowadays, computer-based Geographic Information System (GIS) technology is used in hydrographic process and retrieval of information. This technology can be used in maritime rescue operations to access geographical data and information. Normally, the data obtained are in the form of nautical charts and hydrographic charts. With GIS technology, these data can be delivered in a suitable digital format. In this regard, a study towards the development of interactive maritime rescue application system and database development for nautical chart based on the GIS concept was developed for the Port of Pasir Gudang, Johor, Malaysia. The software used to develop the maritime rescue application system are ESRI MapObjects 2.4, ArcView 3.1, Microsoft Visual Basic 6.0 and Microsoft Access 2007. In addition, end-users can access and update information in the database from time to time in a cost-effective manner, if changes have been identified. Moreover, it can assist end-users to make queries such as locating vessels in danger areas and availability of nearby fire, rescue and medical services.

ABSTRAK

Pada masa kini, teknologi Sistem Maklumat Geografi (GIS) berasaskan komputer telah digunakan dalam proses hidrografi dan perolehan maklumat. Teknologi ini boleh digunakan dalam operasi penyelamatan maritim untuk akses data geografi dan maklumat. Umumnya, data-data yang diperolehi adalah di dalam bentuk carta nautika dan carta hidrografi. Dengan teknologi GIS, data-data ini dapat disampaikan dalam format digital yang sesuai. Sehubungan dengan ini, satu kajian ke arah pembangunan sistem aplikasi penyelamatan maritim secara interaktif dan pembangunan pangkalan data bagi carta nautika berdasarkan GIS telah dihasilkan. Perisian yang digunakan untuk membangunkan aplikasi system penyelamatan maritim adalah *ESRI MapObjects 2.4*, *ArcView 3.1*, *Microsoft Visual Basic 6.0* dan *Microsoft Access 2007*. Data yang digunakan dalam kajian ini adalah untuk kawasan Pelabuhan Pasir Gudang, Johor, Malaysia. Di samping itu, pengguna juga dapat mengakses dan mengemaskini maklumat yang terdapat dalam pangkalan data dari semasa ke semasa secara kos efektif sekiranya terdapat sebarang perubahan yang dikenal pasti. Ia juga dapat membantu pengguna membuat pertanyaan seperti untuk mencari lokasi kapal di kawasan bahaya, perkhidmatan bomba, penyelamat dan perkhidmatan perubatan di kawasan yang terhampir.

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LIST OF ABBREVIATIONS

ADO	– ActiveX Database Object
AIS	– Automatic Identifier System
API	– Application Programming Interface
BASIC	- Beginners All Purpose Symbolic Instruction Code
CAD	– Computer Aided Drawing
CZM	– Coastal Zone Management
DAO	– Database Active Object
DBMS	– Database Management System
DGPS	– Differential Global Positioning System
ECDIS	– Electronic Chart Display
ECS	– Electronic Chart System
ENC	– Electronic Navigational Chart
EPIRB	- Emergency Position-Indicating Radio Beacon
ESRI	– Environmental System Research Institute
GIS	– Geographic Information System
GMDSS	– Global Maritime Distress and Safety System
GPS	– Global Positioning System
GUI	– Graphical User Interface
HIS	– Hydrographic Information System
HTML	– Hypertext Markup Language
IHO	– International Hydrographic Organization
IMO	– International Marine Organization
MMEA	– Malaysian Maritime Enforcement Agency
MRCC	– Maritime Rescue Coordinating Center
MRSC	– Maritime Rescue Sub-Center
MRI	– Marine Research Infrastructure

MSRR – Malaysian Maritime Search and Rescue Region

MSI – Maritime Safety Information

MSDI – Marine Spatial Data Infrastructure

NGDI – National Geospatial Infrastructure

ODBC - Open Database Connectivity

RMN – Royal Malaysian Navy

SAR – Search and Rescue

SDI – Spatial Data Infrastructure

SENC – System Electronic Navigational Chart

SOLAS – Safety of Life at Sea

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CHAPTER 1

INTRODUCTION

1.1 Background

Marine search and rescue (SAR) can be defined as the search for and provision of aid to people who are in distress or imminent danger. According to the International Convention on Maritime Search and Rescue, some areas have a well-established organization for search and rescue that is able to provide assistance promptly and efficiently but not all countries have such a organization. In 1979, the International Convention Maritime Search and Rescue aimed at developing an international SAR so that when an accident occurs, the rescue of persons in distress at sea will be co-ordinated by a SAR organization.

The responsibilities of SAR Convention are: the parties of the convention are required to ensure that arrangements are made for the provision of adequate SAR services in their coastal waters; the parties follow the operating procedures of emergencies or alerts during SAR operation; the parties are required to establish ship reporting systems which enables the interval between the loss of contact with a vessel and the initiation of search operations to be reduced; and also to help permit the rapid determination of vessels which may be called upon to provide assistance, including medical help when required.

Following the adoption of the 1979 SAR Convention, the International Maritime Organisation(IMO) Maritime Safety Committee divides the world's oceans into 13 search and rescue areas. Each of the countries concerned has delimited

search and rescue regions for which they are responsible. Figure 1.1 below shows the search and rescue areas.

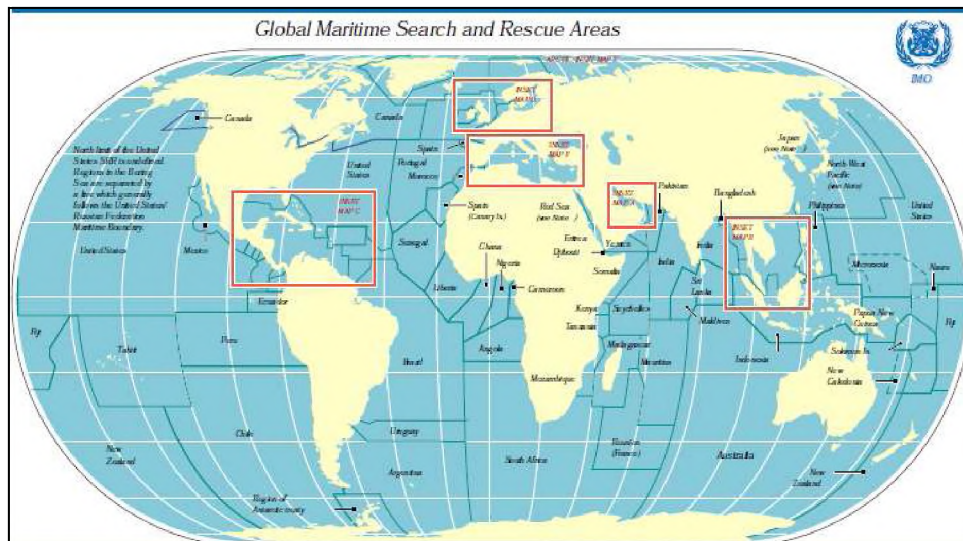


Figure 1.1 Search and Rescue areas

(Source: International Convention on Maritime Search and Rescue, 1979)

The search and rescue operation in Malaysia is operated by the Malaysian Maritime Enforcement Agency (MMEA). The responsibilities of MMEA in search and rescue tasks are detection of maritime incidents, coordination and control of maritime SAR operations within Malaysian areas, providing SAR resources to assist in humanitarian and civil incidents. MMEA has established a Maritime Rescue Coordinating Center (MRCC) and five sub-centers named Maritime Rescue Sub-Centers (MRSC) for the purpose of coordinating search and rescue operations at sea in the Malaysian Maritime Search and Rescue Region (MSRR).

The MRSC operation centre, established by MMEA to control and coordinate Maritime SAR operations, is small in nature and requires only the facilities available within the region concerned. Each centre has its own area of responsibility. The MRSC established in Malaysia are located at Langkawi, Johor Bahru, Kuantan, Kuching and Kota Kinabalu. Figure 1.2 shows the search and rescue areas in Malaysia.



Figure 1.2 Search and Rescue areas in Malaysia

1.2 Problem Statement

Nautical charts are graphic representations of a maritime area that include information about the depth of water, obstructions and other dangers to navigation, and other features that are useful to the mariners. The nautical charts are essential tools for marine navigation and it may take the form of paper charts or Electronic Navigational Charts (ENC).

According to the standards set up by International Hydrographic Organization (IHO) and the International Maritime Organization (IMO), Electronic Navigational Chart is a relatively new technology that provides significant benefits in terms of navigational safety and operational efficiency. More than simply a computer display, an electronic chart is a real-time navigation system that integrates a variety of information that are displayed and interpreted by the mariner. It is an automated decision aid capable of continuously determining a vessel's position in relation to land, charted objects, aids-to-navigation, and unseen hazards.

In practice, there is a system that is used for SAR, which is Global Maritime Distress Safety System (GMDSS). The basic concept of GMDSS is that search and rescue authorities ashore, as well as ships in the immediate vicinity of a ship in distress, can be rapidly alerted to the distress incident so that assistance can be provided in a coordinated search and rescue operation with minimum delay. The system also provides for urgency and safety alert and the broadcast of Maritime Safety Information (MSI), which are weather report and navigation warnings. Therefore, under SOLAS 1974 conventions, the GMDSS operation is divided into sea areas where it is defined by the governments and uses the criteria recommended by IMO. The GMDSS enables a ship in distress to send an alert using various radio systems. These systems are designed such that the alert has a very high probability of being received by either shore rescue authorities or other vessels in the area.

The advantage of this system is that it is an amalgam of various individual radio systems, both terrestrial and satellite. Although this system is equipped with high communication devices and technology, it still has a weakness where there is no facility of GMDSS in many areas of the world, including South Pacific nations. In addition, most vessels operating through many areas are not GMDSS equipped. Other than that, there are false alert problems in the GMDSS system. The root of this problem is the lack of practical experience of GMDSS equipment on board by trained personnel and improper use of GMDSS equipment by inadequately trained personnel. The system is focused on the use of radio communication from ship-ship and ship-shore and in SAR operations.

Therefore, this research develops a maritime rescue application system based on the information contained in the nautical charts such as medical and fire and rescue assistance, depth, beacons, and others. The maritime rescue application system uses the Geographic Information System (GIS) approach where information is gathered and structured in a database. Therefore, in marine search and rescue operations, access to geographical data and information is vital to properly respond to an emergency or incident. The situation must be analyzed within the many dimensions such as the location of injured seamen on the ship, detection of overdue vessel, and others. To minimize the unexpected and unpredictable in emergency

management, it is necessary to gather and structure the information in a database for use in a risk assessment, or in a contingency or operational plan, and during an actual emergency response using the Geographic Information System (GIS) approach.

Thus, the software that is used in this research is GIS software from ESRI (Environmental Systems Research Institute), which is MapObjects 2.4 to develop the system. ESRI MapObjects 2.4 is chosen because it allows the programmer to add dynamic mapping and Geographic Information System (GIS) capabilities to the existing Windows applications or to build custom mapping and GIS solution.

1.3 Research Objectives

The specific objectives of this research are to:

- i. develop a Maritime Rescue Application System using the Geographical Information System (GIS) approach;

design a database as a medium for collection, storage, and data processing for the purpose of maritime rescue application system; and

analyze the results of the application based on the manipulations of the database.

1.4 Research Scope

To ensure that this research is carried out effectively and achieves the objectives, the scope of this research is determined as follow:

i. **Data**

The research area is the Port of Pasir Gudang (MAL 6128) with the scale of 1:10 000. The represented chart needs to be converted into vector format, which is provided by the Royal Malaysian Navy (RMN). In order to develop the applications, the chart needs to be digitized into digital format.

ii. **Hardware and Software**

Due to the highly interactive map, the characteristic or specification of the hardware must be of high performance. Table 1.1 below shows the hardware characteristic of the system development:

Table 1.1 Hardware characteristics

Requirement	Specification
Memory / RAM	512 MB or 1GB (recommended)
Hard disk	160 GB

The softwares used for this research are Esri MapObjects 2.4, AutodeskMap 2004, ArcView3.1, Microsoft Access 2007, and Microsoft Visual Basic 6.0. The details are discussed in Chapter 3 and the characteristics of the softwares are shown in Table 1.2.

Table 1.2 Software characteristics

Requirement	Specification
Operating System	Microsoft Windows XP Professional 2002, SP 2
Softwares	a) ESRI MapObjects 2.4 b) Microsoft Visual Basic 6.0 c) Autodesk Map 2004 d) ArcView 3.1
Database	Microsoft Access 2007

1.5 Research Significance and Benefits

The significance of this research is to provide effective and efficient data management using GIS application and data distribution to the end-users. The integration of attribute and spatial data through digital medium such as a database, allows a user to analyze the logic or analyze the attribute and spatial data that are stored in a database. In addition, through the database development, it saves time, cost, and effort where the user can easily access the database. Furthermore, the information in the database can be updated by the user in an effective way.

With the development of maritime rescue application system, an opportunity is provided for a better working environment, particularly to a navigator. In other words, this research benefits some organizations, such as the Royal Malaysian Navy, Marine Department, and others.

1.6 Summary of the Thesis

There are five chapters in this research. The synopsis for each chapter is discussed below:

- i. **Chapter 1** : This chapter explains the background of the research including the problem statements, purpose, objectives and scope of the research, significance and benefits of the research, and the research methodology.
- ii. **Chapter 2** : This chapter explains the literature towards the development of a nautical chart to an electronic chart. The chapter also covers the research on marine and rescue, and the roles of GIS in hydrography. In addition, the software and scripting language are also discussed in this chapter.
- iii. **Chapter 3** : This chapter explains the analysis of questionnaires, procedure of data preparation, database design, and development of a dynamic map.
- iv. **Chapter 4** : This chapter focuses on the results and analysis of the marine rescue application system.
- v. **Chapter 5** : This is the last chapter of this thesis. This chapter explains the conclusions and recommendations of the research.