A Study of the Development of Taiwan Maritime Casualty Database System

BY

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ABSTRACT
With the aim of creating a complete maritime casualty database which will facilitate an efficient maritime safety management system for Taiwanese government, this study designs and establishes a Taiwan Maritime Casualty Database System (TMCDS). Following the guidelines from the Code for the Investigation of Marine Casualties and Incidents of the IMO and also through a comparative study resulting from the different maritime investigation authorities, this study structures a comprehensive component of such a database. Further, based on the Structured Query Language (SQL) Command and adopting the technology of Active Server Pages (ASP), and Active Data Object (ADO), a three-tier maritime casualty database structure is created through Web server for the convenient of database management for either client side or server side interactively.

1. Introduction

A proper investigation and analysis of maritime casualties and incidents can lead to a greater awareness of casualty causation and providing useful remedial measures. Taking into account the rights and obligations of coastal and flag States, under the provisions of articles 2 and 94 of the United Nations Convention on the Law of the Sea (UNCLOS), a flag State shall cause an inquiry into certain casualties or incidents of navigation which might pose a risk to life or to the environment, involve the coastal State search and rescue (SAR) authorities, or otherwise affect the coastal State. Also, under relevant IMO conventions, such as SOLAS regulation I/21 and MARPOL 73/78 articles 8 and 12, each Administration undertakes to conduct an investigation into any casualty occurring to ships under its flag subject to those conventions and to supply the IMO with pertinent information concerning the findings of such investigations. The Load Lines Convention article 23 also requires the investigation of casualties.

In compliance with these international regulations, many countries establish a specific national authority to carry out maritime casualty investigations. For example, Australian Transport Safety Bureau (ATSB), British Marine Accident Investigation Branch (MAIB), Japanese Marine Accidents Inquiry Agency (MAIA), New Zealand Transport Accident Investigation Commission (TAIC), Swedish Board of Accident Investigation, Transportation Safety Board of Canada (TSB), and US Coastguard Office of Investigation and Analysis and US National Transportation Safety Board (NTSB). In addition, international organisations such as IMO Maritime Safety Committee, European Maritime Safety Agency, Marine Accident Investigators

International Forum (MAIIF), and International Transportation Safety Association have devoted themselves towards safer shipping and cleaner oceans.

Despite the best endeavours of the international organisations and flag states, casualties and incidents resulting in loss of life, loss of ships and pollution of the marine environment continue to occur. In fact, to learn from the casualty itself is one of the most effective measures to reduce the risk of occurrence of next casualty. Therefore, the analysis of causalities through different methodologies and techniques, such as incident modelling, causal analysis, event-based approaches, check-list approaches, mathematical models of causation, and comparisons, to identify and eliminate the regulatory, managerial, hardware, software, human or organisational failures or factors leading to a casualty is important. However, these techniques can only be successfully employed on the basis of an accurate, detailed, and accessible maritime casualty database management system.

This study, therefore, aims to structure a comprehensive three-tier maritime casualty database system through Web server. The system design follows guidelines from the Code for the Investigation of Marine Casualties and Incidents of the IMO and also through a comparative study results from the different maritime investigation authorities. Moreover, this study is to create a prototype of TMCDS, which will be a useful tool to facilitate an efficient maritime safety management for Taiwanese maritime safety authorities.

2. Existing Maritime Casualties Investigation in Taiwan

Taiwan straddles the Tropic of Cancer, about 200 kilometres off the eastern shore of the Chinese mainland. It is strategically located in the East China Sea, between Japan and Korea to the North, and Hong Kong and the Philippines to the South. With a land area of 36,000 square kilometres, it is comparable in size to the Netherlands.

Maritime transport is vital to Taiwan's trade-oriented economy. Almost 99.59% of imports and exports in Taiwan were transported by sea (Chen, 2004a). According to the International Trade Statistics 2003 by WTO, Taiwan was the world's 14th largest exporter and 16th largest importer. In addition to the Taiwanese domestic fleet, there are well over two hundred ships with foreign flags transiting Taiwanese waters daily from the Pacific Ocean to the South China Sea. Besides, Taiwan has in excess of twenty-seven thousand registered fishing vessels ranging from very small non-powered crafts to very large ships. Eighty-one percent of the vessels are less than fifty tonnes in displacement. These large amounts of not-well equipped fishing vessels and small general cargo carriers crossing the Formosa Strait between Taiwan and China are not only increasing the risk to the mariners navigating in this high-density sea traffic area but also to the marine environment and properties (Chen, 2004b).

Taiwan's maritime casualty database is governed by different administrative authorities. Harbour authorities are responsible for all the reported maritime casualties that occur in their administrative region, and report to the Ministry of Transport and Communication. Reports of casualties from fishing vessels are kept by the Fisheries Agency of the Council of Agriculture under Executive Yuan. The Taiwan Coast Guard Administration keeps data of all Search and Rescue cases. The Environment Protection Agency keeps records of marine pollutions.

The recording of maritime casualties' data by different government agencies indicates that the fatality and missing rates are fairly high. According to the information collected from harbour bureaus, an average 290 cases of maritime casualties occur annually in the SAR responsibility area of Taiwan. As far as fishing vessels are concerned, there are about 509 cases each year, but it has been suggested that there are missing figures regarding the fatalities arising from fishing vessels casualties

Table 2.1 Statistics of Maritime casualties
(1.1.1992~31.12.2002)

Data collected from Harbour Bureaus Ministry of Transport and Communication

Year	Number of Casualties	Vessel Damage	Vessel Sunk	Injured	Death/ Missing
1992	372	148	63	23	50
1993	299	137	41	7	54
1994	280	153	43	13	32
1995	214	95	39	4	30
1996	301	142	35	8	75
1997	306	143	19	6	15
1998	295	120	40	7	42
1999	315	133	68	13	44
2000	287	142	64	10	112
2001	276	105	44	50	36
2002	254	81	41	13	29
Total	3199	1399	497	154	519
Average	290.82	127.18	45.18	14	47.18

Definition of Casualties by MOTC includes: Collision, Grounding/ Stranding, Fire, Explosion, Oil Spill, Capsized, Machinery Failure, Extraordinary and Others

Data collected from Fisheries Agency (FA) Council of Agriculture, Executive Yuan

Year	Number of Casualties	Vessel Sunk or Missing	Death	Serious Injured	Injured	Missing
1992	451	124	89	13	49	73
1993	275	53	70	12	19	38
1994	433	49	69	11	8	43
1995	378	39	65	12	9	40
1996	1032	155	73	10	19	65
1997	441	42	46	12	30	21
1998	552	49	59	12	39	25
1999	527	96	62	6	77	18
2000	519	96	68	16	38	14
2001	556	109	58	11	92	20
2002	442	70	59	8	51	18
Total	5606	882	718	123	431	375
Average	509.6	80.2	65.3	11.2	39.2	34.1

Definition of Casualties by FA includes: Weather Damage, Engine Breakdown, Collision, Flooding/Leaking, Grounding/Stranding, Fire, Propeller Twisted and Others

because of the inaccuracy in reporting the actual number of crew on board (Chen, 2003). Consequently, it is estimated that the actual number of lives lost might be somewhat higher than that provided in the official statistics (Table 2.1).

Comparing with countries which have a national authority to carry out maritime casualty investigation, the Taiwan's maritime safety matters are governed by different government authorities, but the fact is that none of these agencies could represent a true picture of maritime casualties in Taiwan (Chen, 2004). As a consequence, this leads to an inefficient and ineffective management system of the investigation of maritime casualties, which will impede the achievement in preventing or reducing the risk of occurrence of another casualty by learning from pervious casualties. Additionally, it is anticipated that in the future, once the waters is open to leisure boats and various maritime activities, or the removal of ban on direct shipping between mainland China and Taiwan, the number of maritime casualties may further increase. Hence, with the shortcomings of existing maritime safety management system and the consideration of the possible increase in the volume of traffic, and in order to achieve the goal of increasing effectiveness and working towards a seamless integration with international procedures on the maritime accident investigation, it is necessary for the government to have a comprehensive and efficient maritime safety management system to be in place to address such crucial situations.

Revealed by this study, the current data of maritime casualties kept in different agencies are mainly hardcopy only, with some in Microsoft WORD format. Furthermore, information collected from these agencies are generally basic, limited and sometimes very rough. Only very limited cases are investigated or discussed. This does not comply with IMO MSC/Circ 953 and other requirements. Hence, with the aim of establishing an efficient maritime safety management system, it is necessary for the government to compile data of maritime casualties from different agencies and create into a complete maritime casualty database.

Table 3.1 TMCDS Developing Environment

FRONT-END	Visual Studio6.0, Mse6.0, Frontpage 2000
DATABASE	Access 2000
WEB-SERVER	Internet Information Server (IIS) 5.0
PLATFORM	MS-Windows 2000, MS-Windows NT Server 2000
TOOLS	Microsoft Development Environment (Mse6.0), Frontpage Server Extension, Microsoft Office2000, WS_FTP, Microsoft Internet Explorer6.0, Adobe Photoshop5.0

3. Structure of Maritime Casualty Database

3.1 Development Environment

With its three-tier architecture, this Taiwan Maritime Casualty Database System (TMCDS) aims to create a user-friendly environment through wide, interactive, and accessible internet at http://www.safetysea.org. The client-side (user interface) system is used as browser to connect the interactive function provided by web server and Maritime Casualty Database on server-side.

TMCDS employs ActiveX Data Objects (ADO) and Active Server Pages (ASP) techniques to retrieve data from a SQL Server database. Active Server Pages (ASP) is a standard programming system for Internet applications hosted on the server-side execution environment in Microsoft Internet Information Server (IIS). APS enables users to open a compile-free application environment, in which HTML pages, scripts, and ActiveX server components can be combined to create powerful Web-based business solutions to be dynamic and interactive by embedding scripts, i.e. either VBScript or JScript, Microsoft's alternative of JavaScript. The environment of developing TMCDS are summarised as follows:

3.2 Data Structure

The basic database structure of TMCDS is designed on the basis of Taiwan's existing maritime casualty report forms collected from different administrative agencies, and relevant resources such as:

1. IMO Sub-Committee on Flag State Implementation - 5th session, casualty database construction submitted by Norway, and reports submitted by Netherlands and Australia.
2. IMO Resolution A.849 (20), Code for the Investigation of Marine Casualties and Incidents
3. IMO Resolution A.884 (21), Amendments to the Code for the Investigation of Marine Casualties and Incidents (Resolution A.849)
4. IMO MSC/Circ.953, MEPC/Circ.372, Reports on Marine Casualties and Incidents, Revised harmonized reporting procedures - Reports required under SOLAS regulation I/21 and MARPOL 73/78 articles 8 and 12
5. Norwegian Maritime Directorate, KS-0197 E Marine Casualty Report
6. Guidelines and Investigators Manual, Marine Accident Investigator's International Forum
7. Guidelines and report forms from Australian National Search and Rescue Manual (Australia), National Search and Rescue Manual and SAR Seamanship Reference Manual (Canada), National Search and Rescue Committee (USA), Search and Rescue Manual (IMO/ICAO)

According to the characteristics of each casualty, data structure are categorised into static data and dynamic data through the following five data types to explain casualties, namely, characters (attribute, phrase), logic, number, date, and summary.

Static data are data that will not be affected by accident and incident, such as particulars of ships (Table 3.2) and information on seafarers (Table 3.3).

Table 3.2 Static Data Structure- Particulars of Ships

Name of field	Content	Type of data		Name of field	Content	Type of data
imo_num	IMO number	character		pre_class	previous class society	character
nat_num	National reg number	character		keel_laid	keel laid (yyyy/mm/dd)	date
ship_name	name of ship	character		deli_date	delivery date (yyyy/mm/dd)	date
flag_state	flag state	character		Dwt	DWT(tons)	number
ship_type	type of ship	character		Hull_mater	hull material	character
Grt	GRT(tons)	number		Hull_constru	hull construction	character
Length	length overall	number		Build_yard	building yard	character
Width	width of ship	number		Hull_num	hull number	character
ship_class	classification ship	character		Crew_num	number of crew	number
shipowner	registered ship owner	character		passen_num	number of passengers	number
Manager	ship manager	character		data_source	source of data	character
pre_name	previous names	character		writer	import	character
pre_flag	previous flag	character		write_date	date to import	character

Table 3.3 Static Data Structure- Information on Seafarers

Name of field	Content	Type of data		Name of field	Content	Type of data
Rank	rank	character		Tele	telephone	character
Crew_name	crew name	character		Serv_com	service company	character
addre_in	address	character		Hold_lice	License hold	character
nation_in	nation	character				

The structure of dynamic data is created on the basis of the SHEL model to describe data with respect to the occurrence and consequences of a casualty (IMO, 2000a). These dynamic data include On-scene data (Table 3.4), Previous 96 hours activities (Table 3.5), Ship's factors (Table 3.6), Environmental factors (Table 3.7), Human factors (Table 3.8), and Consequences of the incident (Table 3.9).

Table3.4 On-scene Data

Name of field	Content	Type of data		Name of field	Content	Type of data
ship_caur	course	number		Visib	visibility scale	character
Speed	speed (knots)	number		Wind_scale	Beaufort scale	character
Wind_caur	wind course	character		sea_state	state of sea	character
Etd	ETD: (yyyy/mm/dd): (hh:mm)	Date, time		Swell_state	Douglas swell	character
Eta	ETA: (yyyy/mm/dd): (hh:mm)	Date, time		Water_depth	depth of water	number
Weat_conti	weather notation	character				

Table3.5 Previous 96 hour's activities (D-X day of casualty)

day\time	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
D-4																								
D-3																								
D-2																								
D-1																								
D-X																								

Table 3.6 Ship's Factors

Name of field	Content	Type of data		Name of field	Content	Type of data
Struct_fail	structural failure	logic		equi_fail	failure equipment	character
design_fail	failure to ship's design	logic		Cargo_cause	cause to cargo	character
main_fail	failure machine	character		oth_ship_cause	other cause of ship	summary

Table 3.7 Environmental Factors

Name of field	Content	Type of data		Name of field	Content	Type of data
othship_unact	other ship unsafe action	logic		aids_fail	failure of aids navigation	character
busy_water	busy water	logic		exter_cause	external	character
sea_fact	factors of sea	character		oth_enviro_fact	other environment factor	summary
weat_fact	factors of weather	character				

Table 3.7 Environmental Factors

Name of field	Content	Type of data		Name of field	Content	Type of data
othship_unact	other ship unsafe action	logic		aids_fail	failure of aids navigation	character
busy_water	busy water	logic		exter_cause	external	character
sea_fact	factors of sea	character		oth_enviro_fact	other environment factor	summary
weat_fact	factors of weather	character				

Table 3.8 Human Factors

Name of field	Content	Type of data		Name of field	Content	Type of data
phys_fact	mistake of physical factors	character		crew_viol	crew violation	character
phyc_fact	mistake of psychological factors	character		crew_unsf_act	crew unsafe action	character
soc_med_fact	mistake of social and medical factors	character		Contri_acci	latent conditions to contribute accident	character
work_env_fact	mistake of workplace and environment	character		oth_hum_fact	other human factors	summary

Table 3.9 Consequences of the incident

Name of field	Content	Type of data		Name of field	Content	Type of data
loca_date	local date(yyyy/mm/dd)	date		dea_mis_pass	dead or missing passengers	number
loca_time	local time(hh:mm)	date		dea_mis_oth	dead or missing other person	number
Posit	position(latitude ,longitude)	character		Serinj_crew	seriously injured crew	number
Locate	location	character		Serinj_pass	seriously injured passengers	number
ev_cont	continuous event	number		Serinj_oth	seriously injured other persons	number
ev_ord	event order	number		tankoil_pol_type	oil in tankers- pollution	character
ev_type	type of event	character		cargoil_pol_type	oil cargo-pollution	character
oth_ship_name	other name of ship	character		Chem_pol_type	chemical in bulk-pollution	character
Pilot_onbo	pilot on board	logic		Dango_pol_type	dangerous goods-pollution	character
ship_end	consequence of the ship	character		pol_quan	quantity of pollution	number
dea_mis_crew	dead or missing crew	number		Sum	summary of events	summary

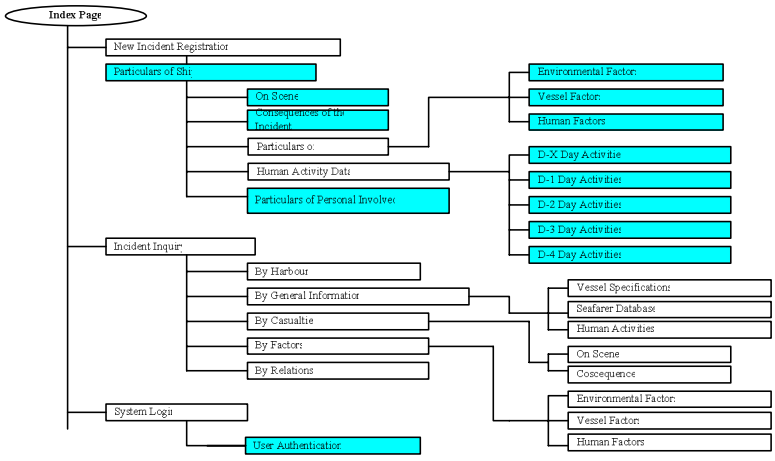

Figure 4.1 HIERARCHICAL STRUCTURES OF THE

4. System and Module Design

4.1 System Structure

The TMCDS provides persons the data required for maritime research and investigation. The HTML script is used in TMCDS to construct the basic web page for user interfaces, followed by inserting into ASP script code and SQL script to control database. The web-hierarchical structures of the system could be simplified as Fig 4.1.In TMCDS, three modules, namely, management module, operation module and storage module are designed. Each module is connected to the others by different levels of functions and authentications.

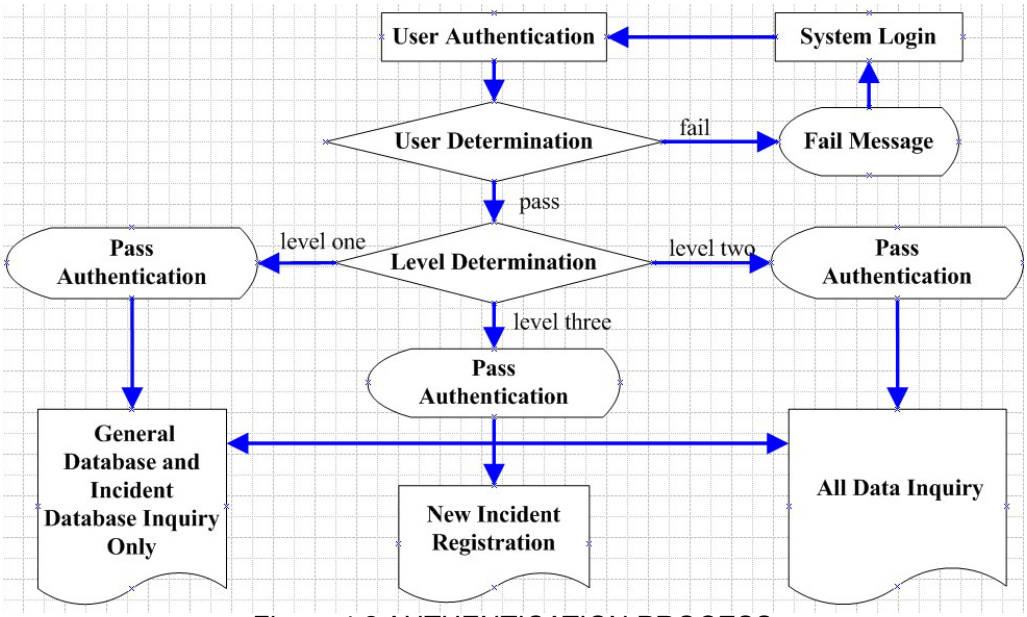

Figure 4.2 AUTHENTICATION PROCESS

4.2 Management Module

The management module is designed to guard this system. For security purposes, this system is only accessible by authentic users. Through an application procedure, eligible users will be authorised to have a level of access right (Figure 4.2). Level one user could interrogate the general casualty database. Level two users are entitled to access into all casualty databases. Only level three users are qualified to register a new casualty or perform data modifications.

The process of new incident registration or data modification is shown in Figure 4.3. The process could be divided into four parts, including general information, causes, consequences, and functions of inquiry.

4.3 Operation Module

The operation module consists of user interfaces and enquiry functions provided by the TMCDS. Users are categorised into general users, relation inquiry users and incident information providers (Figure 4.4).

4.4 Storage Module

The storage module comprises three different databases under main tables, attribute tables, and management tables. Information stored under the main tables including both categorised and classified static and dynamic data. Database stored under the attribute tables consists of all defined elements of different data such as type of ship, ship's hull, wind, weather conditions, type of event etc. Management tables consist of names, passwords and all personal information of the system users. Enquiry into the system needs to follow the different interfaces to access different tables. (Figure 4.5)

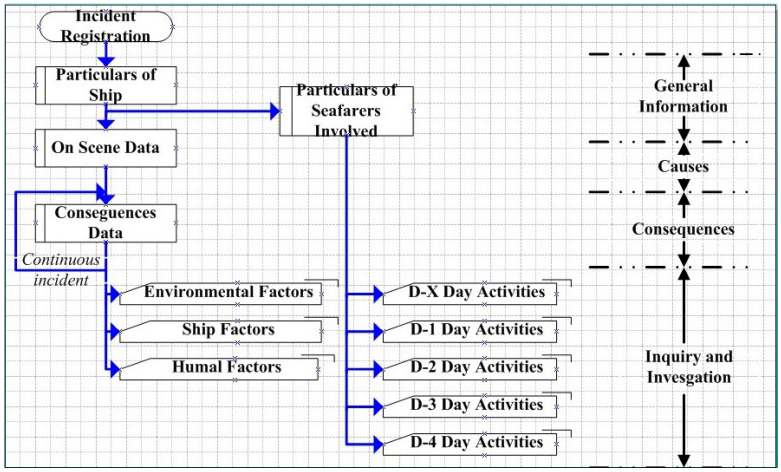

Figure 4.3 INCIDENT REGISTRATION PROCESS

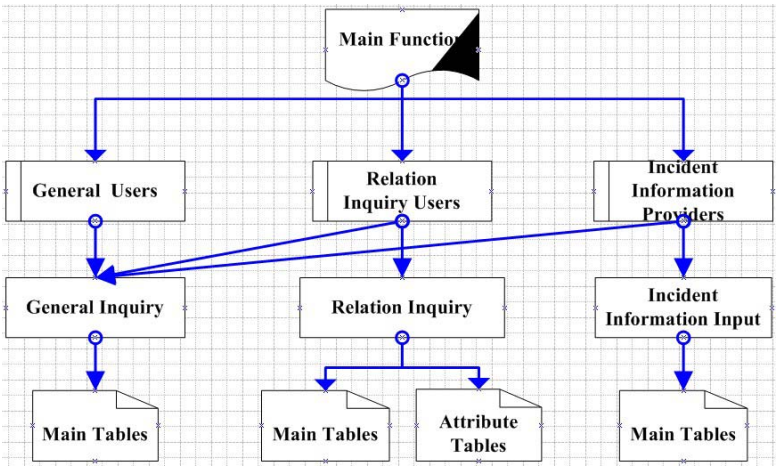

Figure 4.4 OPERATION PROCESS

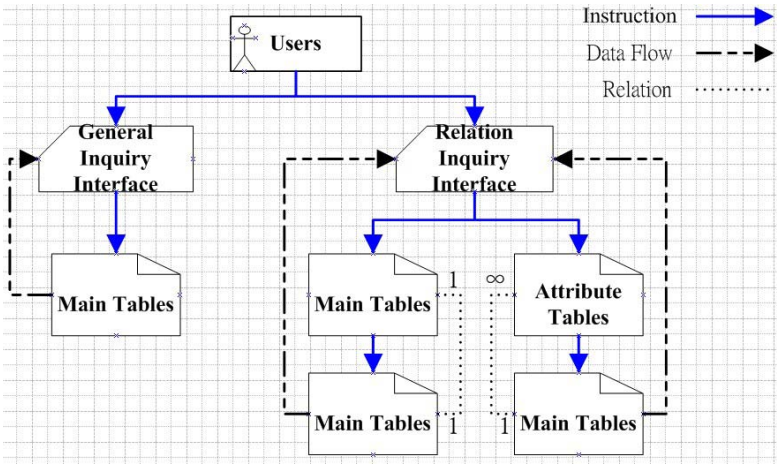

Figure 4.5 SYSTEM ENQUIRY STRUCTURE

5. Operational and Functional Tests

5.1 Database Creation

To register a new casualty case, a total of 460 fields of data are expected. These static and dynamic data include ship's particulars (69), information on seafarers (7), on-scene data (84), previous 96 hours activities (120), ship's factors (34), environmental factors (24), human factors (77), and consequences of the incident (45) etc. After a successful registration, a confirmation message will be replied to the user by the system with a code delegated to this casualty and the user is allowed to proceed with all the following data registration.

Figure 5.1 Registration of ship's particulars

Figure 5.2 Confirmation of registration of ship's particulars

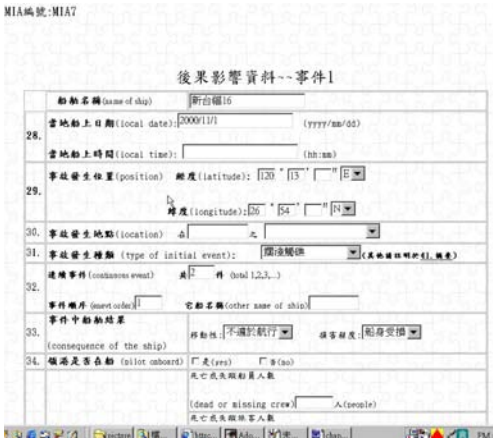

Figure 5.3 Registration of consequences of the incident

5.2 Administrative Enquiry

Administrative enquiry is established according to the regions of administrative responsibility of harbour bureaus and source of data provided by different harbour authorities and government agencies. Criteria of enquiry include ship's particulars, characters, and consequences of casualty

Figure 5.4 Data from server side

5.3 Relation Enquiry

Relation enquiry is created to carry out an advanced search for users enquiring into the system by setting relational criteria that are more specific. Six types of relation enquiry are provided as follows:

1. ship, rank, and personnel activities
2. types of ship, and consequences factors
3. types of ship, characters of casualty, and ship particulars
4. characters of casualty and on-scene data
5. location of casualty and on-scene dada
6. pollution and on-scene data

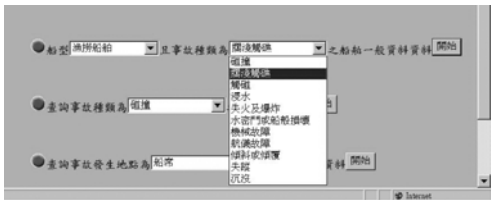

Fig 5.7 Relation enquiry by types of ship, characters of casualty, and ship

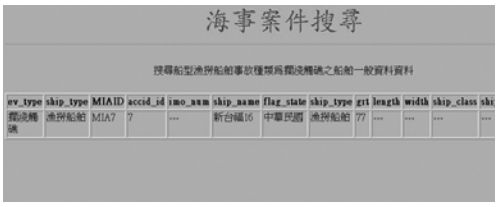

Figure 5.8 Results of relation enquiry

6. Conclusion

Shipping, fishery, and all the maritime activities are extremely important to Taiwan, which has been enjoying remarkable achievements in these fields fostering Taiwan's economic growth in the last four decades. However, through an examination of Taiwan's maritime casualties' records, there is clear evidence showing that Taiwan's maritime achievements are building upon the sacrifice of life, loss of ships, pollution of the marine environment, and uncountable loss of properties.

Information technology in Taiwan has been enjoying a high reputation worldwide, and Taiwan has been the world's fourth-largest computer hardware supplier since 1995. The information technology industry is relatively strong, popular, acceptable and accessible to the public. However, the utilisation of IT as an administrative tool to supervise Taiwan's maritime safety affairs seems sluggish or even stagnant. There is no doubt that maritime safety issues in Taiwan are alarming, and there is a strong need to diagnose Taiwan's maritime safety system. Data collected from maritime casualties is one of the most important links in the chain leading to effective measures to reduce the number of maritime casualties. Hence, the development of Taiwan's maritime casualty database system is essential and vital.

Although this prototype TMCDS system is developed with very limited research funding support, its operational functions, management functions, and storage functions have successfully embedded in the system. Moreover, a total of 2927 casualty cases have also been registered in the system by the authors. Now, the TMCDS has been becoming an important tool and been attracting researchers and interested parties' enquiries.

Following the requirements set by international organizations and referring to different maritime casualty databases from many developed maritime countries, this prototype TMCDS is planning to improve its functions to a more convenient environment for search, retrieval, and management access to data in its database. The structure of the database will be expanded to include data, text, pictures, voice, and possibly video images. The integration with ECDIS or GIS is currently under study. In addition, TMCDS is also planning to add a data exchange program to receive casualty data from other countries for further maritime safety analysis.

Last but not least, with an advantageous position of IT and economic strength, Taiwan has its wonderful environment for system development. However, the desirable and ideal TMCDS is still in the future. To receive Taiwan government's support and approval is one issue; to convert government's maritime casualty administrative people from original paper works to a new computerized system and key-in details of all existed cases is another, even a challenge!

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BIOGRAPHY

A Study of the Development of Taiwan Maritime Casualty Database System

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Dr Solomon Chen is currently an Associate Professor of the Department of Merchant Marine and the Head for the Centre of Maritime Safety and Security at the National Taiwan Ocean University. Between 1993 and 2003, he has acted as a Secretary of the College of Maritime Science, Head of the Research and Development Office, Head of Department and Head of Shiphandling Simulator Centre at the National Taiwan Ocean University. He has previously held a position as Visiting Scholar at the Australian Maritime College from February to September 2004.

Dr Chen holds a PhD from the University of Wales College of Cardiff. His research interests centre around maritime safety and security as well as maritime education and training. For last 12 years, Dr Chen got involved in 49 research projects and conducted as a principal investigator or chairperson in 30 of these projects and a co-investigator or co-chairperson in 8 of these projects. He is the Chief Editor to the Journal of Taiwan Maritime Technology Institute, and a council member of many Maritime Affairs Committees in Taiwan.