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A research on application of Formal Safety Assessment in the typical field grid cell supervision model of China MSA

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A Research on Application of Formal Safety Assessment in the Typical Field Grid Cell Supervision Model of China MSA

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2013

DECLARATION

I certify that all the material in this research paper that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this research paper reflect my own personal views, and are not necessarily endorsed by the University.

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Title:**A Research on Application of Formal Safety Assessment in the Typical Field Grid Cell Supervision Model of China MSA**

Degree: **MSc**

Abstract

As supervision objects of different field grid cells differ, risks in cells also differ, thus risk control supervision measures adopted differ as well. To promote the dynamic grid supervision, scientific tool should be used to identify risks and hidden dangers in different cells, and targeted supervision measures should be taken.

Through the research on the application of formal safety assessment (FSA) to maritime field supervision, this research report sorts out the representative field grids (15 terrestrial grids) in local jurisdiction. According to the characteristics of potential safety risk source in on-site grid, it divides local maritime on-site grid into 7 categories and takes one typical grid cell with the most representativeness in each category. Based on risk information such as ship, personnel, environment, type of passenger/cargo, management, hidden dangers, hidden violations, or time bucket and category of accident, the paper carries out an analysis and assessment and lists risks of typical grad cells. Besides, through collecting risk information from multiple channels, it tries to set up risk database to perfect typical grid cells in local jurisdiction and make targeted proposals for supervision according to risks in different typical grid cells and their supervision characteristics, so as to finally optimize existing field supervision model and promote the accuracy of maritime

supervision and the efficiency of management.

Key words:

Formal Safety Assessment; Identification and Assessment of Maritime Safety Risk; Supervision Measures

Introduction

1.1 Research Origin

With the continuous mature development of the concept of "controllable water safety" of China Maritime Safety Administration(MSA), actively grasping the safety risk in local jurisdiction has become an inevitable orientation for the development of maritime business, and if guided by scientific risk management method or tool, twice the result with half the effort will be achieved. Along with the construction of maritime grid dynamic law-enforcement mechanism, the allocation of advanced information-based technological means and equipment, and the implementation of scientific procedure management, loop-locked management system and standardized management behavior, conditions and foundation to achieve dynamic management of maritime safety risk are increasingly mature.

As a method recommended by International Maritime Organization, formal safety assessment (FSA) can apply the theory of risk management in the grid maritime supervision model, so as to promote the controllability of maritime safety risk and accelerate the transformation from post-event, experienced, extensive field supervision model to refined, dynamic and scientific model based on beforehand prevention, concurrent monitoring and after-event control.

1.2 Research Background

In recent years, maritime system has made more investment in grass-roots maritime law-enforcement agencies, including the improvement of office condition, the increase of law-enforcement personnel and vehicles, the equipment of "Maritime Hand", etc. In addition, the attention paid to field supervision in law-enforcement supervision service is increasingly enhanced. However, the existing maritimefield management model is still at a post-event, experienced and extensive state. Firstly, the initiation of field supervision behavior always focuses on the notification of

post-event information. For instance, after visa or approval procedure of ship has been handled, static law-enforcement personnel notify dynamic law-enforcement personnel of related inspection information, and then field personnel carry out inspection by boarding. If (danger) accident happens, field law-enforcement personnel always initiate the emergency response procedure only after receiving the information of accident (danger). Secondly, field inspection behavior strives for comprehensive coverage, but the methods, scope and emphasis of inspection alwaysrely on daily accumulated experience, without much good effect. For instance, according to the report, various inspections such as personnel-certificate checking, on-duty inspection, anti-pollution inspection, draught inspection, stowage of goods, and prevention of strong wind for a ship have been developed, plus lots of time spent on boarding, but it still ends up with "nothing abnormal detected". Thirdly, the supervision is of an extensive pattern and high cost. For jurisdiction safety, maritime law-enforcement units have invested lots of human resources, financial resources, material resources and intellectual resources, but since law-enforcement personnel are always busy, they have no time to consider and optimize the cost-benefit ratio between administrative cost and safety benefit. Thus, it has become a subject deserving full research and application.to transform the extensive maritime law-enforcement mechanism, actively control the safety risk in jurisdiction with relatively reasonable administrative cost, and explore more efficient and scientific dynamic law-enforcement mechanism of risk management.

In 2011, Jiangsu MSA and China MSA required that maritime agencies should list maritime grid and dynamic law enforcement into work items and establish grid law-enforcement mechanism for maritime dynamic supervision, to meet the requirement of rapid of the shipping economy development, which means that determined grid responsibility should be divided, specific risk sources should be found out to improve the pertinence of control, different risks should be divided to control administrative (cost) resource allocation, and information about safety risk and related resources should be enriched in multiple channels, so as to strengthen the

flexibility, promptness and dynamic nature of supervision.

Formal safety assessment also requires timely collection of information from multiple channels to identify risks, dynamically assessment of risks to grade risks, bringing forward risk control measures to control risks, inspecting whether the risk control measures are within reasonable cost-benefit ratio (the pay of administrative resources and safety effect obtained), and selection of the optimal risk control measures to enhance the management efficiency and effect, so as to control two elements of safety risk: accident consequence and occurrence frequency.

1.3 Research Purpose

Through the research on the application of formal safety assessment (FSA), this research report sorts out the representative field grids (15 terrestrial grids) in local jurisdiction. According to the characteristics of potential safety risk source in field grid, it divides local maritime field grid into 7 categories and takes one typical grid cell with the most representativeness in each category. Based on risk information such as ship, personnel, environment, type of passenger/cargo, management, hidden dangers, hidden violations, or time bucket and category of accident, the paper carries out an analysis and assessment. Besides, through sorting out risks of typical grid cell and collecting risk information from multiple channels, it tries to set up risk database of typical grid cell in local jurisdiction and make targeted proposals for supervision according to risks in different typical grid cells and their supervision characteristics, so as to finally optimize existing field supervision model and promote the accuracy of maritime supervision and efficiency of management.

1.4 Research Method

This paper mainly adopts literature review, field investigation, and summary of work experience to collect data, applies the theory and method of formal safety assessment and combines with the actual condition of China MSA’s typical grid to make an

intensive study of risk sources of the China MSA's representative grids and put forward routes and methods to achieve application.

1.5 Main Research Achievements

With innovative mechanism, FAS risk control mechanism has been introduced, scientific and refined law-enforcement model has been established, and existing grid management model has been optimized.

It sorts out representative risk sources in terrestrial jurisdiction, analyzes and assesses safety risks based on factors including ship, personnel, environment, type of passenger/cargo, management, time bucket, etc., tries to set up risk database of typical grid cell and make targeted proposals for supervision.

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LIST OF ABBREVIATIONS

DMU Dalian Maritime University

FSA Formal Safety Assessment

IMO International Maritime Organization

MCA Maritime and Coastguard Agency

MSA Maritime Safety Administration

VTS Vessel Traffic Service

CCTV closed circuit television

AIS Advanced Information Systems

GIS Global Information System

GPS Global Positioning System

VHF Very High Frequency

1 Related Concepts and Application

1.1 Formal Safety Assessment

In 2007, the International Maritime Organization (IMO) accepted the proposal of UK Maritime and Coastguard Agency (MCA) and officially passed the *FSA Guide* on the 74th MSC Conference, recommended formal safety assessment (FSA) as a strategic thought, and applied it the making of maritime safety and maritime environmental protection conventions and rules, design of ship and supervision of ship safety.

See Figure 1 for details of its major process:

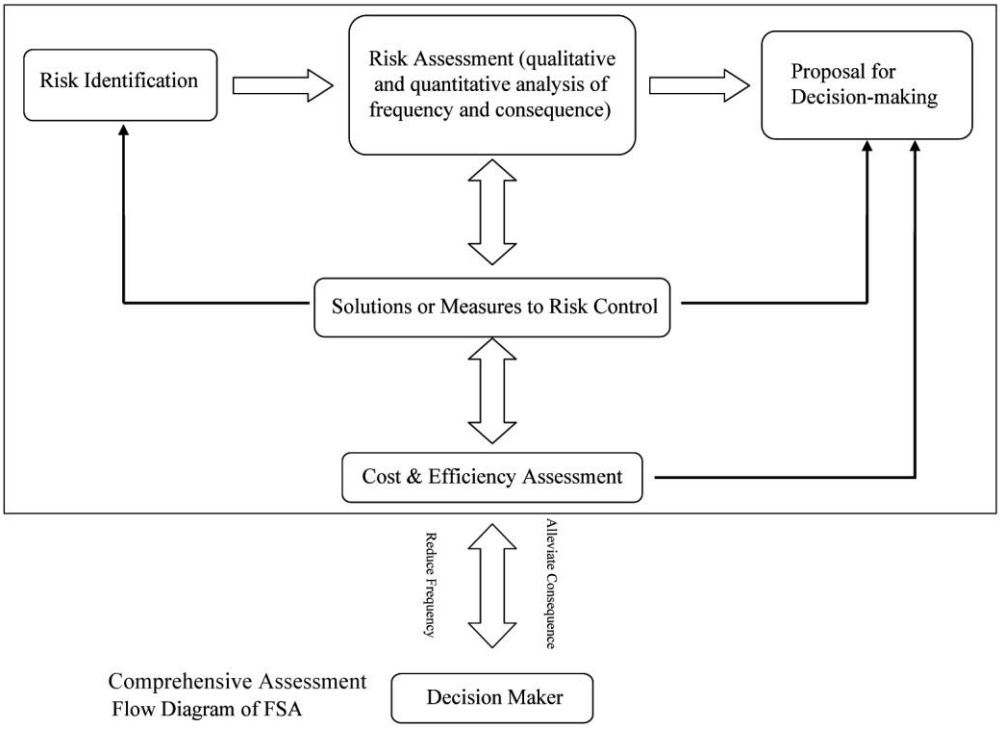

Figure 1 Process of FSA

Formal safety assessment (FSA) refers to a systematic method to promote maritime safety including protecting life, health, environment and property through risk analysis and cost & efficiency assessment. Its steps include: (1) risk

identification; (2) risk assessment; (3) risk control measures and solutions proposal; (4) cost and efficiency assessment; (5) decision-making proposal. This method is mainly used to forecast (or post-assess) the possibility of accident before (or after) it and systematically and comprehensively consider all aspects affecting safety from an overall perspective, so as to take necessary safety measures, to avoid the occurrence of accident, reduce the possibility of accident or mitigate the consequence of accident; besides, it also accesses the cost benefit of risk control measures, so as to increase initiative and pertinence for conventions to make of revise and management of maritime safety risk.

1.2 Maritime Risk

Maritime risk refers to all abnormal activities related to maritime dynamic supervision in the grid, including navigation management, ship management, crew management, danger and anti-pollution management, as well as accident emergency management. Abnormal phenomena caused by management elements in the grid therefore become maritime risks.

1.3 Grid Management

Grid management means borrowing the idea of computer management to divide management objects into a number of grid cells according to certain standards and making use of modern information technology and coordination mechanism among all grid cells to achieve effective information exchange and transparent organizational resources sharing among grid cells, to finally reach the goal of integrating organizational resources and promoting management efficiency.

1.4 Grid Management of Maritime Dynamic Supervision

Grid management of maritime dynamic supervision refers to classified, hierarchical and level-to-level management of space and events, which takes maritime dynamic law-enforcement command management system and office automation management

system as platform, “4S” and “Maritime Hand” technology as methods, and grid cell as basic unit. Through establishing dynamic law-enforcement command system based on command center and combining grid cell management with element management, it defines the responsibilities of each grid and brings about the refining of maritime management space and precise classification & positioning of navigation environment elements.

1.5 Law-enforcement Resources

Law-enforcement resources refer to human and intellectual resources including maritime law-enforcement personnel, emergency experts, etc., as well as various ships, vehicles, implement and facilities available for maritime law enforcement or emergency disposal.

2 The Necessity and Feasibility of Formal Safety Assessment in Typical Field Grid Cell Supervision Model of the China MSA

2.1 Necessity

2.1.1 The Necessity for Transforming from Treatment Post-event to Beforehand Control of Maritime Field Supervision

The introduction of FSA into the field supervision model can provide reference for the emphasis and orientation of safety work in the future, to grasp the initiative of maritime field supervision work and strengthen beforehand control of safety risk. Besides, it enables existing passive, experience-based and post-event field supervision model to stride forward the orientation of predictable, beforehand measurable and active maritime supervision.

2.1.2 The Necessity for Transforming from Experience Management to Scientific Management of Maritime Field Supervision

As a relatively mature application of industrial risk management theory to maritime management practice, FSA is advantaged with structuring and systematization. The MCA has made use of FSA to establish maritime accident risk management system, carry out analysis of accident rule, and regularly develop safety assessment of environment in jurisdiction. After good results have been obtained, FSA was also recommended to the IMO and won approval rapidly. The application of risk management to grid management will be in favor of looking for risk rules, clearing the emphasis of daily supervision, optimizing law-enforcement resources, strengthening the pertinence of maritime field management, and promoting efficiency and benefit.

2.1.3 The Necessity for Compatibility with Technological Superiority of Grid Management

The digitization of grid management objects is in favor of integrating with dynamic risk database in FSA. Based on information technology, grid management uniformly codes the grid, accident, event, etc. With dynamic network information management platform, it brings convenience to the compatibility and dynamic input of daily risk data in FSA. Functions of network communication warning support, supervision, and command & coordination in grid management promote the interactivity and timeliness of rapidly optimizing and integrating effective resources and supervision control in FSA. The real-time monitoring function in grid management can also provide strong reference for the adjustment after comprehensive assessment in FSA.

2.2 Feasibility

2.2.1 The Successful Application of FSA Provides Reference for Optimizing Grid Maritime Supervision Model

Since 1988, to control risks of maritime accident, in investigation and pre-control of maritime accident, the MCA applied industrial risk analysis and risk management assessment to shipping risk assessment and safety management, to establish rolling-type risk assessment mechanism and form a system of formal safety assessment (FSA).

In 1993, on the 62nd Maritime Safety Committee of IMO, the MCA submitted the proposal of adopting formal safety assessment (FSA) to promote the maritime safety level and protect maritime environment; additionally, it suggested that the IMO should take FSA as a strategic thought and gradually apply it to the making of maritime safety and maritime environmental protection conventions and rules, design of ship and supervision of ship safety. *It was then immediately accepted and approved the IMO. In 1997, on the 68th* (MSC) Conference, the "*Interim Guide of FSA Application" was formed and passed, and in 2007, the FSA Guide was officially passed on the 74th* (MSC) Conference.

Researchers of China MSA, China Classification Society, Cosco Group, and various scientific research institutions have developed some preliminary studies on the application of FSA. At present, FSA is being popularized and applied to multiple aspects such as legislation of shipping circles, design of ship, construction test, safety management, and accident prevention.

2.2.2 The Development of "Soft and Hard" Maritime Strength Boosts the Establishment of Dynamic Risk Database and Rapid and Reasonable Assessment Dispatching of Law-enforcement Resources

At present, Vessel Traffic Service(VTS), Advanced Information Systems(AIS), Global Information System(GIS), Global Positioning System(GPS), Very High Frequency(VHF), internal & external network ship dynamic database and other maritime information technology methods have been applied widely, the research & development of “Coastal Hand” is promoted steadily, massive information of law-enforcement resource and service object has been collected and integrated widely, and mobile offices are also made possible. In China MSA, the grid cell in jurisdiction has been divided scientifically and reasonably, personnel have received years of training and recruitment, highly educated personnel account for a large proportion in the total number of employees, the variety of professional personnel tends to be complete, and the concept of law-enforcement personnel’s handling affairs according to standardized procedure has been set up.

2.2.3 Similar to the Principle of FSA, Grid Supervision Can Be Easily Integrated

The purpose of both grid management and FSA risk management of maritime dynamic supervision is to control the value-at-risk of some field and promote the safety loading coefficient of managed objects. The management method of both of them requires recognizing and confirming potential risks of managed objects, checking and ratifying risk source, ascertaining risk grade, selecting appropriate control measures, and forming scientific and loop-locked management system. All of them discard the experience-based management model of post-event management, and pay attention to beforehand prevention and control.

3 An Overview of the Application Mechanism of FSA to Grid Maritime Supervision Model

To simplify the FSA flow diagram, a brief general flow diagram is made through combining with the actual application of maritime field supervision as below:

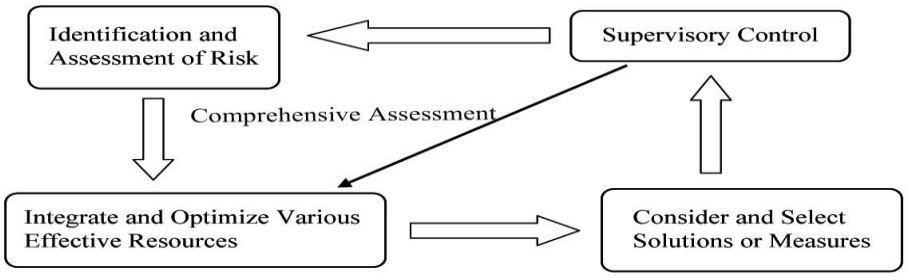

Figure 2 General Diagram of Maritime Application

3.1 Identification and Assessment of Maritime Risk

3.1.1 Identification of Maritime Risk

As an active object, maritime risk needs to be well handled and prevented, thus beforehand troubleshooting is indispensable. The scope of maritime risk troubleshooting in grid mainly includes: risk of human factors, including crew's ineligibility, unsafe act, etc.; risk of ship factors, including unseaworthiness of ship, trouble in cargo handling, overloading transport, illegal passenger carrying, etc.; risk of environment factors, including poor channel conditions, disordered mooring, extreme weather conditions, etc.; risk of management factors, including ship company's absent implementation of safety responsibility system, unreasonable resource allocation, law-enforcement department's absent implementation of supervision responsibilities, etc.; risk of cargo factors, including high physical and chemical danger of cargo, etc.

Through daily supervision & inspection and sole risk troubleshooting, effective methods are adopted to carry out dynamic troubleshooting and identification of risks in the grid. Methods of troubleshooting mainly include: incident cause analysis, safety situation analysis, violations analysis and other maritime business statistic analysis, ship's safety inspection, ship visa, cruising inspection and other daily supervisions, sole troubleshooting and notification (report) to related units, as shown in Diagram 3.

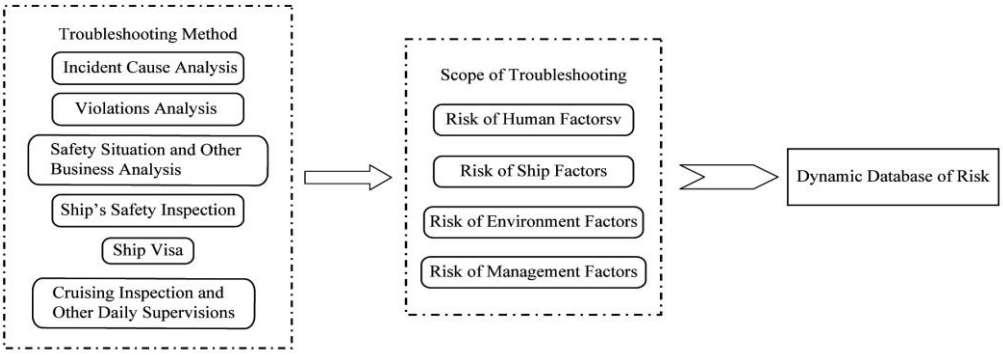

Figure 3 Identification of Maritime Risks

After finding out objective risks, an initial registration (name, type, problems and characteristics of risk) should be carried out and each grid or the risk distribution database (can be involved into the module of information platform supported by "Coastal Hand") of several typical grids should be set up, to be in favor of searching key grid area, type and time bucket of risk (such as grid with great risk, type and time bucket of risk with high possibility in one grid), so as to be conducive to exploring relatively stable rules, as shown in Table 1.

Code of Grid Area	Incident Risk	Potential Risk Source	Time Bucket of Risk
A1	Swell Damage, Wind Damage	Small Yacht, Passenger Ship	Summer/Daytime 1200-1800hrs

. . .	. . .	. . .	. . .
H1	Collision, Stranding, Pollution	Work ship, Sand Ship	Low Tide Time /Nighttime

Table 1 Risk Distribution in Each Grid in Jurisdiction

3.1.2 Assessment of Maritime Risk

According to different properties and types of risks, methods such as case investigation, statistic analysis, comprehensive assessment, and expert consultation can be adopted for risk assessment; and factors such as type of risk, property of risk, characteristics of risk, range of hazard, degree of hazard, difficulty in controlling, social environment and natural environment, as well as assessment results should be fully considered, so as to determine the risk grade.

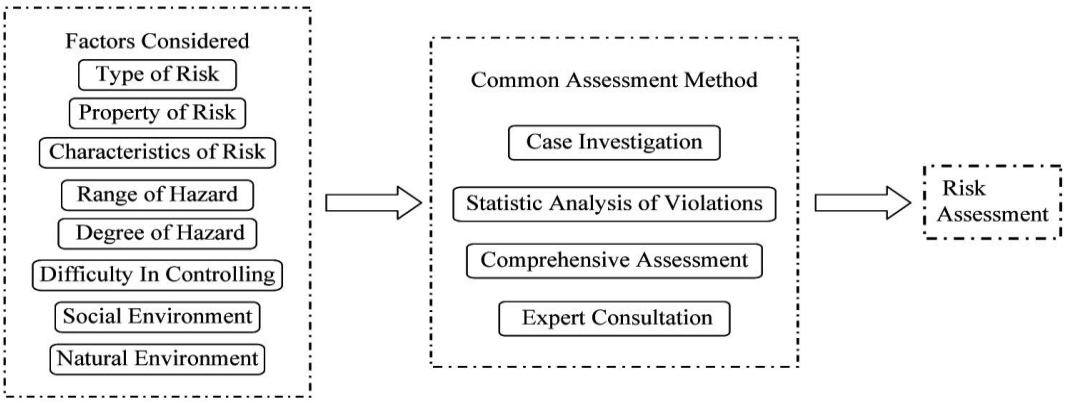

Figure 4 Maritime Risk Assessment

3.2 Effective Resources

Effective resources refer to the sum of internal and external resources including various human resources, materials resources, financial resources, intellectual resources, information and culture resources which can be available and allocated for maritime management activities. To ensure the effective resource allocation, an analysis of resource requirement should be carried out according to the discovered risks (and risk grade) and then resource construction and allocation should be conducted based on the analysis of resource requirement, as shown in Diagram 5.

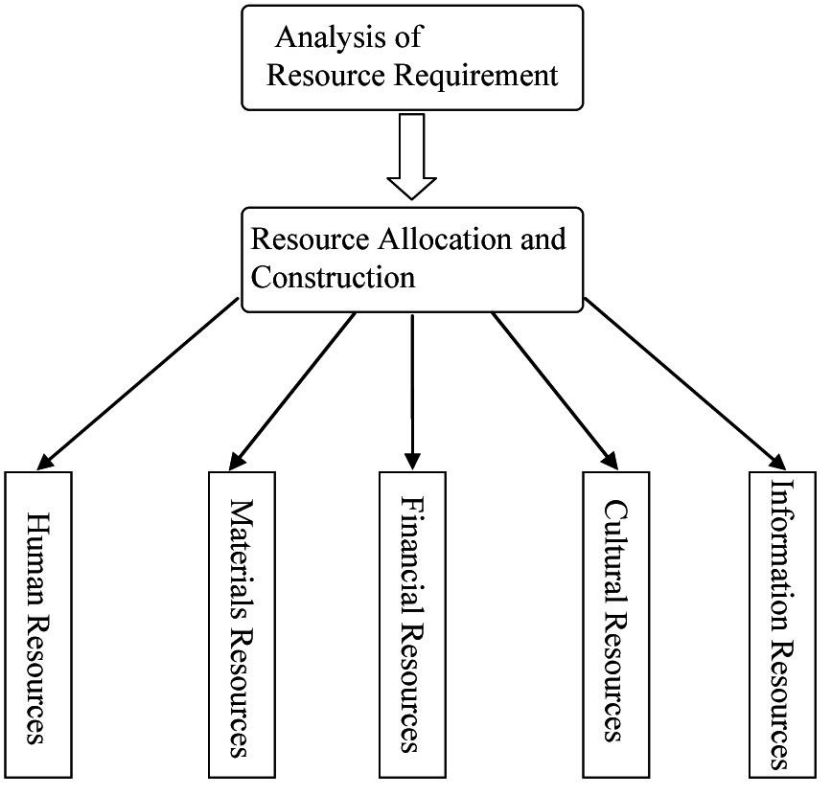

Figure 5 Resource Demand Allocation Based on Risks

3.3 Measures and Solutions Considered

When it comes to maritime measures or solutions, according to different types of risks, applicable legal norms should be found out within the framework of laws and regulations, to work out supervision solutions or behaviors in respects of ship management, ship company management, crew management, emergency management, risk prevention management, navigation management, ship inspection management, etc. In the meantime, according to the variation trend of risk and the aim requirement of risk management, cost-benefit ratio should be assessed comprehensively and supervision measures or solutions should be improved constantly. When achieving the double optimization of administrative cost and risk factors, the dynamic optimized procedure should also meet the requirement of internal specification (such as maritime management system), as shown in Diagram 6.

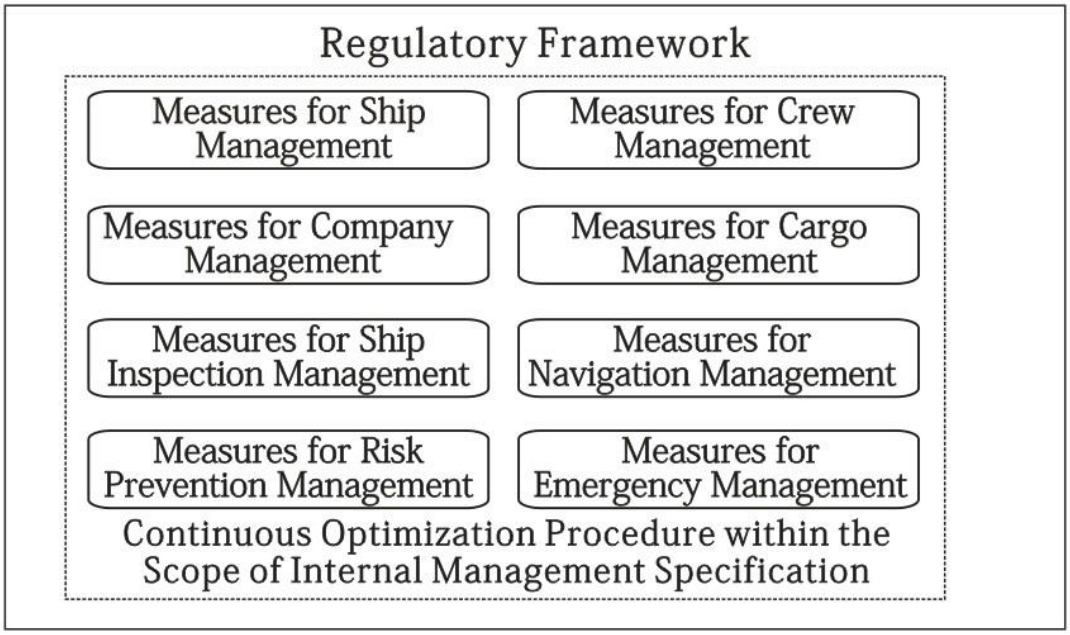

Figure 6 Measures Based on Laws and Regulations

3.4 Supervisory Control

Supervisory control refers to specific measures or actions adopted by maritime agency to reduce, control and handle risks by making use of resources, such as safety inspection of ship, field inspection and other routine supervision methods, to rectify and reform the discovered dangers or defects, so as to reach the goal of risk prevention and control. VHF radio telephone, water safety information stand, GPS safety information service, mass SMS, publicity on internal and external websites, interview and other methods can be used for safety precaution. Besides, resource organization emergency disposal in jurisdiction should be allocated, to reduce risks or loss caused by incident; sole rectification for security & protection, dangerous cargo and anti-pollution should be developed to suppress one or more than one particular risk, as shown in Diagram 7.

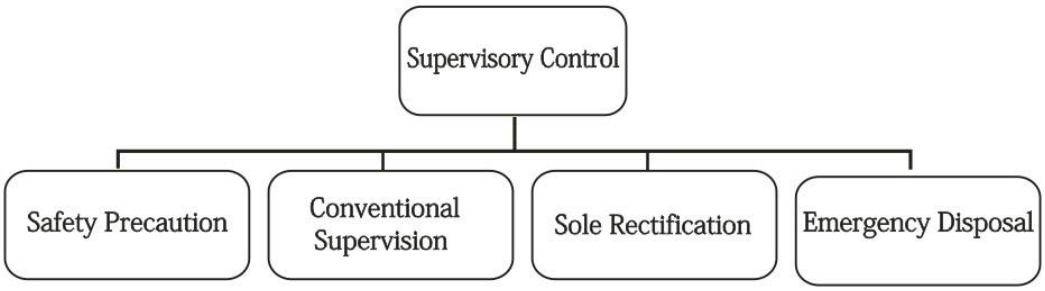

Figure 7 Maritime Supervisory Control

3.5 Comprehensive Assessment

In the process of risk management, maritime agency should timely carry out periodic assessment or comprehensive assessment of the effect of risk management based on monthly, quarter and annual time buckets, with content mainly covering the

effectiveness of supervision solutions and response measures, reasonableness of supervision resource allocation, the conformance of internal and external specifications, etc. In reference to deficiencies and problems discovered, they should timely optimize resource allocation or existing plans and regulate risk control, response measures or maritime resources, to manage risks with the most reasonable cost-benefit ratio.

4 Application of FSA to Grid Maritime Supervision Model of China MSA

4.1 A Brief Introduction to Grid in Local Terrestrial Area of the China MSA

According to the requirements of Guidance for Grid Management Implementation of Jiangsu MSA, the terrestrial grid dynamically supervised by Lianyungang Administration has been divided into 41 terrestrial grids, including 15 ones in local Lianyungang (9 ones in Xugou and 6 ones Lianyu), 12 ones in Guanhe, 11 ones in Yancheng, and 3 ones in Ganyu. 15 local terrestrial grids contain 11 relatively complete risk sources such as yacht, passenger-cargo ship, dangerous cargo ship, liquid cargo ship, shipyard, work ship, sand ship, oil supply ship, oil water recycling ship, bulk cargo ship, and super large-size ship, with considerable representativeness in local jurisdiction. Specific name, characteristics of grid and maritime risk sources are shown in Table 2.

Name of Grid	Risk Sources	Characteristics of the Grid
Xugou Land 01	Work Ship	Mud flat, no quay, occasional dumping-filling work and work ship, proposed floating entertainment center, traffic inconvenience.
Xugou Land 02	Yacht, Shipyard	A shipyard, with an annual building or repairing capacity of about 100 ships, a mass of safe operation and anti-pollution operation within the port, many cases of second-gear and above ship

		berthing; cruising yacht, floating restaurant, and motorboat.
Xugou Land 03	Bulk Cargo Ship, Liquid Cargo Ship	Marginal berth, big effect caused by orographic winds, focusing on bulk cargo ship and liquid cargo ship, mutual utilization of berth length, Berth 65 and 66 specially serving as the quay berth for dangerous goods.
Xugou Land 04	Bulk Cargo Ship, Large-size Cargo Ship, Oil Supply Ship, Oily Water Receiving Ship	Marginal berth, many bulk cargo ship and large-size cargo ship; quay of public service ship, passenger ferry, oil supply ship, and oil waster receiving ship.
Xugou Island 05	Bulk Coal Ship, Harbor Tug	High-grade quay berth, berthing ship focusing on bulk cargo ship, high requirement for underkeel clearance, frequent forced discharge, tight shipping date of power coal ship, Berth 37 serving as the base of harbor tug.
Xugou Land 06	Container Ship, Scheduled Passenger-Cargo Liner	Marginal berth, obvious effect caused by orographic winds; focusing on container ship, many ships with container capacity of 6000TEU and above, fast cargo handling, tight shipping date, large cargo handling capacity of packaging dangerous goods; Berth 31 and 32 also serving bulk cargo ship, unopened Berth 24-28, Berth 31 and 28 serving passenger-cargo liner, with short period and tight shipping line.
Tombolo Land 01	Dumping-filling Work Ship	In dumping-filling construction
Tombolo Land 02	Yacht	Two bathing beaches: Dashawan and Sumawan; in peak tourist season, many tourist take a yacht to travel off the coast.

Tombolo Land 03	Yacht, Oil Tanker	Shoreline, a yacht club, many traveling-the-sea passenger ships, specialized quay for oil depot, lots of construction sites, berthing zone for shipping boat.
Lianyun Land 01	Dangerous Cargo Ship	Specialized berth for dangerous goods, Berth 14 also serving bulk cargo ship.
Lianyun Land 02	Ship Bypassing Berth Grade	Old quay, often berthed with ships surpassing berth ability; Berth 9 has been upgraded and improved, Berth 10 is greatly affected by topography; harbor tug base inside.
Lianyun Land 03	Large-size Bulk Cargo Ship	High-grade quay berth, focusing on large-size bulk cargo ship, unopened 2 quays and 4 berths.
Lianyun Land 04	Sand Ship, Work Ship, Ship Building and Repair Yard	Many nuclear power stations and construction sites, illegal sand ship operation in Gaogongdao and Bantiaozha, fishing boat quay, ship building and repair yard.
Xuwei Land 01	Work Ship	Mud flat, no quay, work ship.
Xuwei Land 02	Sand Ship, Work Ship	The quay in south wing of the main port of Lianyungang is being constructed, with many work ships and sand ships.

Table 2 Brief Introduction to Local Maritime Terrestrial Grid

The local terrestrial grid constitutes the jurisdiction scope of Lianyun and Xugou Maritime Office, west from the south side of Linhong estuary, east to the terrestrial area on the south coast of Liezikou in the southeast of Xuwei Port, distributed along the coast of tombolo, west dike, and port. See details in Diagram 8 and 9.

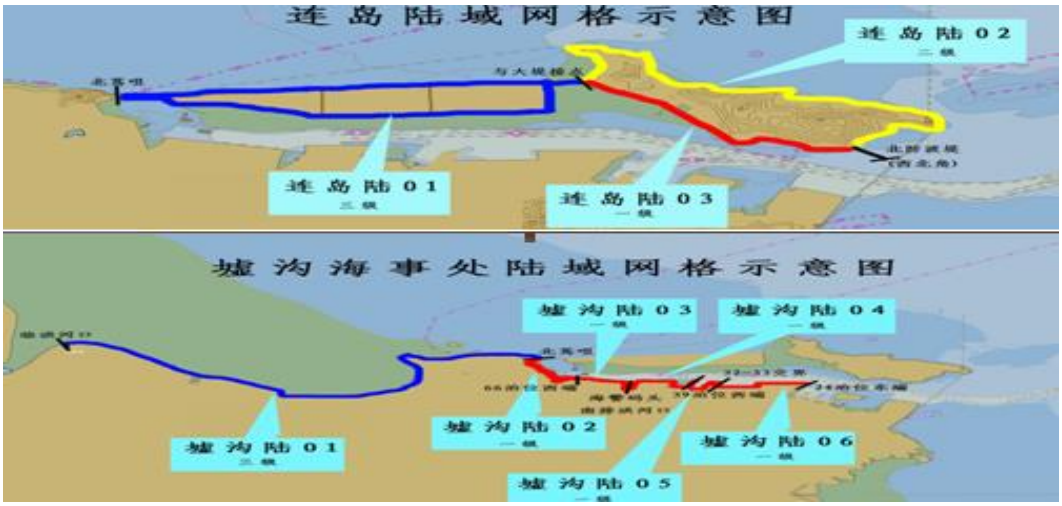

Figure 8 Maritime Terrestrial Grid in Xugou

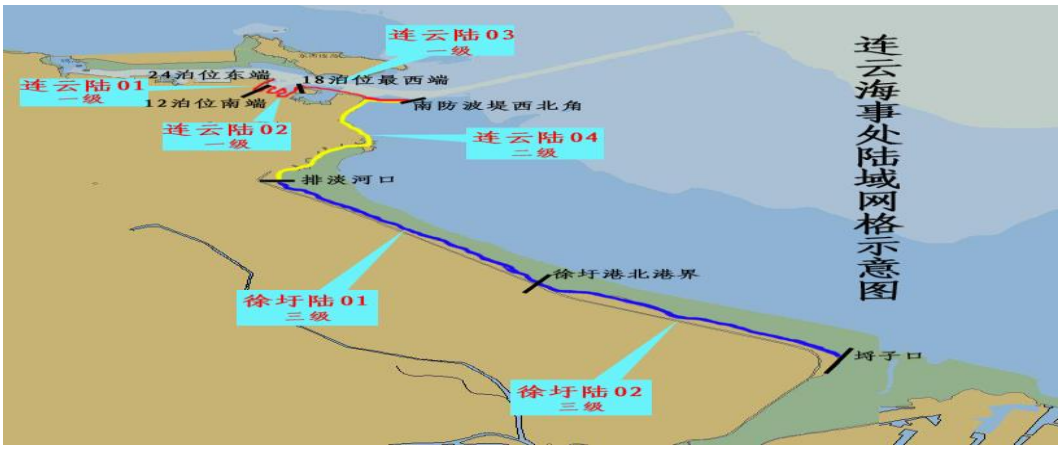

Figure 9 Maritime Terrestrial Grid in Lianyungang

4.2 Identification of Risk Sources and Grid Classification

Based on Table 2 and the supervision characteristics of each grid as well as the distribution of major risk sources, 15 grid cells can be generally divided into 7 categories of typical grid cells:

Construction Grid, such as Xugou Land 01, Tombolo Land 01, Lianyun Land 04, Xuwei Land 01, and Xuwei Land 02; major risk sources include: work ship and sand ship.

Grid of Yacht and Passenger Liner, such as Xugou Land 02, Xugou Land 06,

Tombolo Land 02, and Tombolo Land 03; major risk sources include: yacht and passenger liner.

Grid of Bulk (Large Size) Cargo Ship, such as Xugou Land 03, Xugou Land 04, Xugou Land 05, and Lianyun Land 03; major risk sources include: ship carrying special cargos (concentrate fines, coil steel, bulk and heavy cargos, etc.).

Grid of Shipyard (Dockyard), such as Xugou Land 02 (Berth 67, 68 and 69) and Lianyun Land 04; major risk sources include: shipyard, ship building and repair yard.

Grid of Ship Carrying Dangerous Cargos (Liquid Cargo), such as Lianyun Land 01 and Xugou Land 03; major risk sources include: ship carrying dangerous cargos.

Grid of Container Ship, such as Xugou Land 06; major risk sources include: container ship.

Grid of Small-size Oil Work Ship, such as Xugou Land 04 and Tombolo 03; major risk sources include: small-size oil work ships (refueling ship, oil water recycling ship, etc.).

4.3 Database of Risk Source in Each Typical Grid

4.3.1 Construction Grid (Work Ship, Sand Ship)

Name of Grid	Risk Sources	Hidden Dangers and Risks	Incident Risk	Key Time Bucket

Xugou Land 01, Tombolo Land 01, Lianyun Land 04, Xuwei Land 01, and Xuwei Land 02	Work Ship	Crew	1. Some of the crew fail to receive professional training and get a certificate of qualification; 2. Some of the crew fail to have a valid certificate of competency; 3. Crew are of ragged and commonly low quality; 4. Crew have weaker awareness of anti-pollution and safety than crew of merchant ship.	Construction in shipping lane and harbor basin may easily cause ship collision and result in casualties and damage to ship or pollution incident.	Time bucket of dense navigation; period of poor visibility; rush hours of wharf project construction; nighttime 22:00-06:00
		Ship	1. During construction, several work ships overlook the guard of communications equipment and fail to effectively keep in touch with ships entering and leaving port or VTS; 2. Navigational instrument of several work ships lacks of maintenance or familiar application method, and fails to play its due roles at critical moment; 3. Several work ships are of incomplete certificate or outdated certificate, but they still insist on operating.		
		Environment	1. Work ship occupies shipping lane, which brings great effect upon merchant ships' entering and leaving port; 2. Merchant ships entering and leaving port may frequently come across work ships.		
		Management	1. The construction project department's knowledge of safety management for work ships should be further strengthened; several construction project departments fail to implement main responsibility for safety management and standardized management of work ships; 2. Several construction project departments fail to main responsibility and overlook the management of work ships;		

			3. Ship operators refuse to invest in safety.		

Table 3 Risk Identification and Assessment of Work Ships in Construction Grid

Name of Grid	Risk Sources	Hidden Dangers and Risks		Incident Risk	Key Time Bucket
Xugou Land 01, Tombolo Land 01, Lianyun Land 04, and Xuwei Land 02	Sand Ship	Crew	1. Most crew fail to receive professional training and get a certificate of qualification; 2. Most crew fail to have a valid certificate of competency; 3. Sufficient qualified crew fail to be allocated; 4. Ship owners “pay attention to efficiency but make light of safety”; 5. Sand quay operators and construction entities have weak awareness of safety production.	Poor condition of sand ships, indefinite berthing place and time, and deficient ability of coping with severe weathers may easily cause water penetration, capsizing and sinking of ships, resulting in	Time bucket of extreme weather, period of poor visibility; rush hours of project construction; nighttime 22:00-06:00
		Ship	1. Ship is equipped with poor technology and simple communications facilities; 2. Ship is of no or incomplete certificate, and several ships are inland ships; 3. No report or visa is handled for ship entering or leaving port. 4. Unlicensed business, navigating zone surpassing, and overloading of ship are prominent, which belong to acts of intentionally avoiding supervision; some ships carry out adventure sailing in bad weather; 5. A few ships are even “three no’s” ships.		

		Environment	1. Bad weather conditions (strong wind, rough sea, dense fog, sea ice, etc.) have great effect on ship safety; due to the poor batten-down effect of sand ships, weathers such as strong wind and rough sea may easily cause the ship to sank, and dense fog may cause collision; 2. Merchant ships entering and leaving port may frequently come across sand ships.	casualties and damage to ships; generally low quality of crew may easily bring about violations such as illegal loading & unloading and illegal transport.	
		Management	1. Wading project department's knowledge of safety management of the ship should be further strengthened; 2. It is difficult in managing sand ships, there are too many competent departments, and linkage among departments and the resultant force of safety supervision have yet to be further strengthened; 3. Problems of cross-jurisdiction transport and indefinite management entity exist in several ships; 4. A few ship operators refuse to comply with normal maritime supervision, but adopt methods such as avoidance and even resistance to escape from the management.		
		Cargos	1. Problems such as poor stowage, never calculated stability and overloading exist in sand transport, and drainage system of cargo hold is poor; 2. There is no specially-assigned personnel taking care of cargos; 3. Informally loading or unloading may easily cause damage to cargo hold.		

Table 4 Risk Identification and Assessment of Sand Ships in Construction Grid

4.3.2 Grid of Yacht and Passenger Liner

Name of Grid	Risk Sources	Hidden Dangers and Risks		Incident Risk	Key Time Bucket
Tombolo Land 02, Tombolo Land 03, Xugou Land 02, and Xugou Land 06	Yacht, Passenger Ship	Crew	1. Crew of yacht and motorboat are is poor safety awareness and low quality; 2. Some of the crew fail to have a valid certificate of competency; 3. During peak tourist season, with stronger labor strength and pressure as well as longer work time, it's easy to cause fatigue to the crew; 4. Some company managers have weak safety awareness and low management level.	It's possible to cause one-off overboarding, death or missing, with casualties between 1 and 100.	Daytime from 12:00 to 18:00 during long holidays such as summer vacation, May Day holiday and National Day holiday; period of strong wind and big waves.
		Ship	1. Small-size tourist ships sail by surpassing classification of wind resistance; 2. Motorboats carry passengers; 3. Tourist ships sail by overloading and overspeeding; 4. Short-distance yacht tourists refuse to wear life jacket; 5. During peak tourist season, with passenger flow volume, it is difficult to put an end to violations such as overloading and navigating zone surpassing of small-size passenger ships; 6. Small-size tourist ship companies have poor efficiency and maintenance of ships.		
		Environment	1. The entrance channel of port is narrow, but ship traffic volume is huge; 2. The condition for tourist ship berthing of Haiyifang and West Dyke is poor; 3. Severe weathers such as strong wind and wave; 4. In scenic spots, the operation area of		

			tourist ships and motorboat is easily mixed up with swimming area.		
		Management	1. There are not sufficient law-enforcement personnel during the peak tourist time; 2. Ship companies fail to provide safety education for the crew; 3. Due to the wide on-site supervision points of yacht, safety supervision has yet to be further strengthened; 4. Shipping liner companies specialize in ship chartering, so they cannot directly invest in safety management of ship and crew.		
		Tourists	1. Foreign tourists have poor safety awareness and insufficient safety education.		

Table 5 Risk Identification and Assessment of Tourist Ships in Grid of Yachts and Passenger Ships

4.3.3 Grid of Bulk (Large Size) Cargo Ship

Name of Grid	Risk Sources	Hidden Dangers and Risks		Incident Risk	Key Time Bucket
Xigo Land 03, Xugou Land 04, Xugou Land 05, Lianyun Land 03	Ship Carrying Special Cargos (Concentrate Fines, Coil	Crew	1. Some of the crew have poor safety awareness and responsibility; necessary professional management knowledge and voyage management is still lacked for the transport of special cargos; 2. The crew don’t have necessary professional training and professional quality; 3. The captain overlooks cargo management; 4. With poor responsibility, dock workers and the crew fail to carry out stowage,	In adverse sea condition, ships may capsize or break, causing casualti	Period of loading & unloading cargos in strong wind, big waves, rainy and snowy weathers; nighttime during voyage:

	Steel, Bulk and Heavy Cargos, Etc.)		securing, and loading by rules; 5. Regarding the report or loading & unloading of liquid cargos, rainy and snowy weathers fail to be taken into consideration.	es and damage to ships.	22:00-06:00
		Ship	1. Ships are of an old age; in particular, break-bulk liners sail between China and Korea are old, applicable to the requirement of low old rules; 2. Some ships fail to adopt overload limiter and effective cargo trimming; 3. Necessary protective measures are lacked, such as unequipped simple cargo sampling instrument and gas sampling instrument of ships carrying fine coal; 4. The cargo hold of a minority of coastal small-size bulk cargo ships is of poor weather tightness, so it is easy to cause water penetration during the voyage.		
		Environment	Severe weathers such as strong wind and wave.		
		Management	1. Some ships have old-version or no *Cargo Lashing and Securing Handbook*, and *Stability Booklet* and *Loading Plan* of bulk cargo ships fail to be effectively used; 2. The lashing and securing materials used by port companies fail to meet the requirement of convention norms; 3. There is insufficient investment in maintenance of old ships; 4. Port loading & unloading companies or workers lack special experience in cargo loading & unloading, lack recognition of risk of cargos, and fail to load according to correct loading plan; 5. In reference to ships with the certificate of cargo hold exception,		

			companies have no idea about the cargos unsuitable for loading onto this ship but still carry out stowage.		
		Cargos	1. The statement content of legal cargo materials submitted by the consignor to the captain is incomplete; 2. Large-size ships increase shearing stress and bending moment caused by cargo loading, and relevant calculation fails to be developed in time.		

Table 6 Risk Identification and Assessment of Tourist Ships in Grid of Bulk (Large-size) Cargo Ships

4.3.4 Grid of Shipyard (Dockyard)

Name of Grid	Risk Sources	Hidden Dangers and Risks		Incident Risk	Key Time Bucket
Xigou Land 02 (Berth 67, 68, and 69), Lianyun Land 04	Shipyard, Ship Building and Repair Yard	Crew	1. Due to the temporary employment system of workers in small-size ship building and repair yards, the technological level of ship building and repair is ragged; 2. Workers in small-size yards have poor anti-pollution awareness; 3. Crew with low-grade certificate work on “critical tonnage” ships.	Fire protection, operation incident, and pollution incident.	Peak season of ship building and repair, nighttime: 22:00-06:00
		Ship	1. Newly built or repaired ships accept inspection of unauthorized foreign ship inspection agencies in private, so it is difficult to guarantee the quality; 2. The construction of small-size ships fails to be carried out according to drawings, and phenomenon of private processing exists; 3. Phenomenon of “large-size ship but		

			lower certificate" exists, and standard of equipment is low; 4. Legal supervision is lacked for the quality of repaired ships; 5. Due to the irregular work system of small-size traffic boats serving shipyards, it is easy to cause insufficient manning or short-distance overloading.		
		Environment	1. Located in remote region, shipyards hardly report information to maritime agency, and it spends a long time in investigating violations; 2. In terms of the hold cleaning and air purge of small-size ship building and repair yards, the procedure or system of oxygen and gas free inspection before lowering chamber or operating is unsound.		
		Management	1. In small-size shipyards, if there is order, personnel will be seen, but if not, no one will be seen; safety management is discontinuous; investment in safety and anti-pollution is insufficient; 2. Maritime agency fails to strictly supervise shipyards, and supervision personnel and vehicles are lacked.		

Table 7 Risk Identification and Assessment in Grid of Shipyard (Dockyard)

4.3.5 Grid of Ship Carrying Dangerous Cargos (Liquid Cargos)

Name of Grid	Risk Sources	Hidden Dangers and Risks		Incident Risk	Key Time Bucket
Lianyun Land 01, Xugou	Ship Carrying Dan	Crew	1. Due to the insufficient knowledge of the classification of various dangerous cargos and perception of risk, declarers always declare the dangerous cargos	High probability of fire,	Thunder and lightning weather in high

Land 03	gerous Cargos (Liquid Cargos)		toward the orientation of low grade to avoid trouble; 2. The crew have inadequate emergency handling ability of various dangerous cargos; 3. It is difficult to master the fact that whether packing inspectors sign after carrying out on-site inspection or not.	and possible over 50 tons of oil pollution accident.	temperature season in summer during period of operations such as loading & unloading, tank cleaning, and lightering.
		Ship	1. In reference to various dangerous cargos, the ship doesn't have sufficient first-aid medicine; 2. The inspection items in ship-shore connection stable fail to be implemented carefully; 3. Most bulk chemical tankers leave the port with empty load after unloading, so it is difficult to supervise tank cleaning or the water discharge.		
		Environment	1. Scorching weather and thunder & lighting weather.		
		Management	1. A supervision team with rich experience in field work on ships carrying dangerous cargos is lacked, and relevant professional knowledge and operation procedure knowledge of dangerous cargos is absent.		
		Cargos	1. The variety is wide, the characteristics of risks are varied, and countermeasures are different.		

Table 8 Risk Identification and Assessment in Grid of 5.3.5 Grid of Ship Carrying Dangerous Cargos (Liquid Cargos)

4.3.6 Grid of Container Ship

Name of Grid	Risk Sources	Hidden Dangers and Risks	Incident Risk	Key Time Bucket

Xugou Land 06	Container Ship	Crew	1. Coastal crew have inadequate ability of stability calculation and cargo stowage and pay insufficient attention to them; 2. Within short time in port, the crew are easily fatigable; 3. The crew are unclear about the requirement for container inspection and quality control.	In traffic dense and intersection areas, when visibility is poor, it is likely to cause collision accident, and dragging of anchor is likely to happen in windy period.	Rush hours of entering and leaving port, nighttime: 22:00-06:00, haze and windy weather.
		Ship	1. For schedule, the ship speed is relatively fast; 2. With containers piling up above the board, the windward area is large; 3. There are lots of large-size containers (TEU), so it is difficult to operate.		
		Environment	1. Haze and windy weather.		
		Management	1. With high requirement of schedule, the arrangement of ship maintenance always submits to the pressure of operating time; 2. The model of dangerous cargos in existing detection box is time-consuming and labor-intensive, but methods are limited.		
		Cargos	1. The stowage of dangerous cargos within the box is relatively hidden.		

Table 9 Risk Identification and Assessment in Grid of Container Ships

4.3.7 Grid of Small-size Oil Work Ship

Name of Grid	Risk Sources	Hidden Dangers and Risks	Incident Risk	Key Time Bucket

Xugo Lan 04, Tombolo Land 03	Refueling Ship, Oil Water Recycling Ship	Crew	1. The crew are of poor quality and responsibility; 2. The crew fail to be on duty in standardized way, and there is no specially-assigned personnel taking care of the working field; 3. The crew have poor oil pollution emergency skill.	Pollution incident is likely to happen in refueling.	Period of floating oil loading & unloading work, period of strong wind, dense fog and thunder & lightning.
		Ships	1. Ships are old and ship's technical condition is poor.		
		Environment	1. Weathers such as strong wind, dense fog and thunder & lightning.		
		Management	1. Safety management on working site fails to be implemented, oil containment boom layout fails to be carried out, and emergency equipment is inadequate; 2. Ship companies neglect management; 3. The berthing quay is relatively unfixed, which increases difficulty in supervision; 4. Due to the small gross tonnage, it fails to enter system management and various safe operation rules are defective.		
		Cargos	1. If the cost handling oil water with low oil content is higher than operating cost, illegal discharge is likely to happen.		

Table 10 Risk Identification and Assessment in Grid of Small-size Oil Work Ship

4.4 Law-enforcement Resources

Existing law-enforcement resources: about 50 on-site law-enforcement personnel (including Lianyun, Xugou and security station), and about 10 law-enforcement vehicles (including Lianyun, Xugou and security station). Existing law-enforcement ships are small-size and 80% of them are sheltered (except for Coast Guard 091 and 0906). Information facilities such as CCTV, AIS, GIS, VTS and Maritime Hand can monitor most water area of a port, but omnibearing

monitoring of ship's voyage, berthing and operation has not yet achieved. The port is of less than 50 tons of sewage disposal ability. Law-enforcement personnel have good business ability, service awareness, professional ethics and professional dedication, but there is still a large gap from the economic development requirement of the society.

Law-enforcement resources yet to be promoted: the rescue force of large and middle-size ships and air traffic control is lacked, information-based supervision facilities such as CCTV, AIS, GIS, VTS and Maritime Hand are unsound, there is a large gap from the latency-free requirement of information collection, transfer and disposal of information resources, and omnibearing monitoring of water area in port has not yet achieved. The volume of dangerous cargos (liquid cargos) entering and leaving port increases year by year, the emergency anti-pollution ability is less than 50 tons, ship force is insufficient, structure is unreasonable, on-site front-line law-enforcement house-using is strained, tombolo supervision and search & rescue base has not yet built, the demand on existing law-enforcement traffic and human resources is high, and law-enforcement personnel's professional skill, executive ability and service awareness have yet to be enhanced continuously.

4.5 Specific Maritime Supervision Control Measures

As FSA's risk processing and control is based on specific dynamic information, in reference to 7 categories of typical grids, the paper now makes some proposals for general supervision and control measures in the respects of human, ship, environment, management and cargo respectively. In actual supervision, it is essential to carry out assessment and dynamically optimize business processing according to specific risk information.

4.5.1 Construction Grid

4.5.1.1 Work Ship

Supervision Measures for Human Factors:

1. Handle well approval management of sources and strictly inspect the authenticity and effectiveness of ship and crew's certificate;

2. Urge the crew to receive training and certificate of qualification before construction;

3. Strengthen on-site supervision of overwater & underwater construction and promote work ships to implement inspection related to the requirements of safety;

4. Intensify the company's daily supervision and inspection, urge the company to regularly develop safety training activity for managers and the crew, and enhance emergency exercise to promote practitioners' emergency response capability and professional quality;

5. Urge the construction units to strengthen safety education and training for the crew, and promote their safety awareness and working responsibility;

6. Urge the construction project department to reinforce ship's anti-pollution management;

7. Carry out lead sealing for sewerage of ships and strictly control the management of oil supply and acceptance;

8. Enhance anti-pollution inspection.

Supervision Measures for Ship Factors:

1. Strengthen maritime inspection and safety check, and timely correct the hidden

safety risks of ships;

2. Urge the work ships to operate within published construction time and scope, and display navigation shape and light in correct way, to ensure free-flowing communications;

3. Regularly report inspection condition and problems existing in ships to ship companies and construction project department, and urge them to strengthen management.

Supervision Measures for Environment Factors:

1. Remind grand ships of keeping in touch with work ships, to strengthen observation, navigate with caution and pay attention to avoidance;

2. Urge construction units to set rules to implement safety construction management in severe weathers and poor sea conditions, improve emergency response plan, remind operating ships of returning to the port in advance to take shelter from the wind, and strictly prohibit adventure construction in severe weathers and poor sea conditions;

3. Strengthen prevention and early warning, carefully handle early warning information release of severe weathers and poor sea conditions, and strictly perform the standard of navigation prohibition and limit in severe weathers and poor sea conditions.

Supervision Measures for Management Factors:

1. Strengthen source management, strictly approve the qualification of water operating ships, and strictly prohibit ships with defects and hidden dangers from

accessing to construction site; define and fulfill responsibilities of related units and departments, sign safety supervision liability agreement with project unit and constriction unit, and urge companies to perform safety responsibility.

2. Adopt the combination of dredging and blocking, and carry out level-to-level management of sand ships and work ships; assess ships with good conditions, train the crew, equip with necessary life-saving, communications, and simple AIS facilities, prescribe a limit to region and wind scale, and bring into management;

3. Adopt harsher measures for centralized governance of ships with poor conditions.

4.5.1.2 Sand Ship

Supervision Measures for Human Factors:

1. Further strengthen safety publicity education for owners of sand ship, to promote their safety awareness of maritime transport;

2. Strengthen crew training and education;

3. Intensify on-site inspection and strictly investigate the crew's violations such as ineligibility and lack of manning.

Supervision Measures for Ship Factors:

1. Urge companies and ships to strengthen daily maintenance of ships, give further prominence to safety management responsibility of companies and ships, eliminate hidden dangers of accidents, and promote the safety management level of companies and ships;

2. Intensify on-site inspection of ship facilities and prohibit ships with incomplete certificate and manning from engaging in sand transport;

3. Enhance dynamic monitoring of ships, closely rely on local government and unite related functional departments to develop joint law-enforcement action, intensify maritime cruising and on-site inspection, and strictly crack down ships' unlicensed business, navigating zone surpassing, overloading, illegal sand mining and transport, etc.;

4. Through thorough search of visit, investigation, as well as maritime cruising and on-site investigation, grasp sand ship companies' data related to sand collection and transport, for risk assessment.

Supervision Measures for Environment Factors:

1. Strengthen prevention and early warning, and carefully handle early warning information delivery and publication of severe weathers and poor sea conditions;

2. Intensify on-site inspection before the arrival of severe weathers;

3. Intensify the inspection of the crew's on-duty in severe weathers.

Supervision Measures for Management Factors:

1. Unite local governments to urge ship companies to strengthen management;

2. Strengthen the connection among departments and the supervision over the management of ship companies;

3. Intensify maritime inspection of on-site sand ships' operation and timely

investigate violations;

4. Urge related port quays to stop providing operation berth for sand ships;

5. Inspect and supervise all construction project units to implement safety production responsibility, duly carry out interview, and practically rectify hidden safety risks in construction;

6. Actively visit local people, know the trend of sand ships and characteristics of berthing, and require local people to timely report to local government and maritime department when they find sand ships;

7. Establish linkage mechanism based on the joint cooperation among construction unit, maritime agencies such as port of registry, ship inspection and operating port, as well as public security organ.

4.5.2 Grid of Touring Ship (Yacht)

Supervision Measures for Human Factors:

1. Urge companies to strengthen daily management of the crew, intensify the crew's safety knowledge training and education, and enhance their safety awareness and responsibility consciousness;

2. Urge and help companies to strengthen the crew's eligibility training in tourist off-season, strengthen on-site inspection, and strictly fight against violations such as unlicensed business;

3. Urge companies and ships to further improve safety and responsibility awareness, establish sound safety management system, strengthen daily supervision and inspection for the company, and encourage eligible companies to build safety

management system;

4. Urge companies to establish related system, equip with sufficient eligible crew, and ensure the crew's sufficient break time in peak tourist season.

Supervision Measures for Ship Factors:

1. Strengthen on-site inspection, and strictly investigate violations such as overloading, overspeeding, tourists' refusal of wearing life jacket, and sailing by surpassing classification of wind resistance;

2. Report passenger carrying information of yacht to local government and superior competent departments, and manage passenger carrying according to the instruction of the superiors;

3. Urge companies to intensify maintenance of ships, timely update ships, intensify safety inspection of old ships before the arrival of holidays or the peak tourist season, and strictly prevent ships from sailing with "illness";

4. Establish and improve joint inspection system under the leadership of local government, timely develop joint inspection, and strictly cracking down violations such as unlicensed business and illegal passenger carrying.

5. Urge companies and ships to further strengthen safety awareness and responsibility consciousness, intensify on-site inspection and cruising work, and strictly prevent violations including overloading, navigating zone surpassing, etc.

Supervision Measures for Environment Factors:

1. Intensify on-site supervision and inspection for Haiyifang, West Dyke, Huangwo, Tombolo Baths, etc. during holidays, strictly inspect overspeeding of ships, and

prohibit ships from operating by surpassing wave scale;

2. In severe weathers such as strong wind and big waves, timely publish early warning information, carry out on-site inspection, and strictly investigate prohibited operation of ships;

3. Require tourist yacht and motorboats to operate within specially designated area, and prohibit them from passing through densely populated area such as swimming area.

Supervision Measures for Management Factors:

1. Hold safety meeting of ship companies and require them to carry out regular safety education to the crew;

2. Urge companies and ships to timely propagandize knowledge related to safety and life saving to passengers, strengthen passengers' order management by ship, and prevent passengers from gathering on one side, prow, and upper deck of small-size passenger ship;

3. Increase law-enforcement input and law-enforcement personnel's inspection frequency.

Supervision Measures for Passenger Factors:

1. Set up warning board of illegal boarding points, distribute safety leaflet to tourists in bathing place, and require ship operators to timely develop safety training and reminding to passengers waiting for a ship (yacht).

4.5.3 Grid of Bulk (Large Size) Cargo Ship

Supervision Measures for Human Factors:

1. Intensify inspection of the crew's practical operating skill and urge them to strengthen the inspection of cargo stowage state and battening-down effect during voyage, to timely eliminate hidden risk of incident;

2. Urge port side to organize dock workers to develop professional knowledge training of special cargos, strengthen the management before cargo shipment, and reinforce on-site supervision in the process of cargo loading and lashing & securing;

3. Urge companies to propagandize special provisions in respects of stowage, lashing & securing, and battening-down of special cargos including concentrate fines, coil steel, etc., and promote the crew's professional quality;

4. During on-site inspection, intensify the inspection of ship loading, unloading, stowage and lashing & securing;

5. In rainy and snowy weathers, intensify the inspection of loading and unloading of liquid cargos.

Supervision Measures for Ship Factors:

1. Extensively inspect the structure and facilities of old ships;

2. Intensify the inspection of stowage plan of ships.

Supervision Measures for Environment Factors:

1. Strengthen prevention and early warning, carefully handle early warning

information release of severe weathers and poor sea conditions, and strictly perform the standard of navigation prohibition and limit in severe weathers and poor sea conditions;

2. Prohibit ships carrying large-size steel products from sailing in severe weathers such as strong wind and waves;

3. Deliver important weather information to ship side and inspect cargo stowage and lashing & securing.

Supervision Measures for Management Factors:

1. Combine with *Cargo Lashing and Securing Handbook* or *Stability Booklet* to inspect the implementation of ships;

2. Communicate with related operating units, propagandize provisions of related conventions and rules, and use materials with enough strength for lashing and securing:

3. Adopt methods such as safety inspection, company approval and negotiation with the office of liner company to urge ship companies to intensify maintenance of old ships.

Supervision Measures for Cargo Factors:

1. As for large-size bulk ships of this port, inspect if cargo information provided by consignor is complete. For example, inspect if there is a *Grain Loading Certificate* of grain ships at bulk grain dock (Berth 33), if there is cargo information and certificate of limiting water content of coal ship at coal dock, if hazardous gas inspection facility is equipped, and if cargos of this voyage are within the scope of transport allowed by cargo exemption certificate.

4.5.4 Grid of Shipyard (Dockyard)

Supervision Measures for Human Factors:

1. Make use of opportunities of important date confirmation, tonnage measurement review and shipyard lofting, to strictly control shipbuilding technology;

2. Take opportunities of coastline approval inside shipyard, qualification review of shipyard, and propaganda conference of ship inspection rules and regulations, to carry out propaganda, combine with on-site inspection, require equipping with anti-pollution apparatus, implement anti-pollution education, and assist shipyard in improving the quality of personnel;

3. Based on on-site safety inspection and tonnage review, strictly crack down violations such as “critical tonnage” and “large-size ship but lower certificate”.

Supervision Measures for Ship Factors:

1. Investigate the illegal inspection in shipyard (dockyard), and confiscate illegal inspection certificate;

2. With the means of tonnage review, verify violations such as “inconsistency between ship and drawings” and “large-size ship but small tonnage”, and acquire rectification before issuing certificate;

3. Carry out on-site inspection, and intensify manning and overloading inspection of shipyard’s small-size service ships.

Supervision Measures for Environment Factors:

1. Build maritime information report system of shipyard and timely report information of ship survey and repair.

Supervision Measures for Management Factors:

1. Build maritime information report system of shipyard and timely report information of ship survey and repair;

2. Take the opportunity of building annual review of shipyard to inspect the formulation and implementation of internal rules and regulations;
3. Increase vehicle and personnel allocation, and give prominence to source management of ship building and repair of shipyards in jurisdiction under administration.

4.5.5 Grid of Ship Carrying Dangerous Cargos (Liquid Cargo)

Supervision Measures for Human Factors:

1. Verify if the crew of ships carrying dangerous cargos (liquid cargos) are familiar with the nature of dangerous cargos before sailing, and carry out regular exercise;

2. Selectively check on the spot if the declared dangerous cargos accord with the type declared, and set up CCTV on the spot of the dock, to verify if packing inspectors carry out on-site inspection; if false declaration signer is found, it will be recorded on the list of discreditable management and the declaration qualification will be suspended.

Supervision Measures for Ship Factors:

1. Propagandize to ship and management companies, complete with corresponding

medicine in *Maritime Emergency First-aid Guide*, and carry out selective check in forms of safety inspection and tour inspection on the spot;

2. Trace and view the record of *Oil (Cargos) Record Book*, and verify sewage flowing in tank cleaning of bulk ships;

3. Check if requirements of all inspections in ship-shore checklist and P&A handbook have been met both on board and ashore.

Supervision Measures for Environment Factors:

1. Timely remind ship side of the operation approval in severe weathers;

2. Use VTS, etc. to predict scorching and thunder & lightning weathers, carry out targeted early warning, and fully make use of AIS, CCTV and other methods to strengthen the dynamic monitoring of ships at working site.

Supervision Measures for Management Factors:

1. By means of practice aboard, training for dangerous cargo declarer and on-site inspector, survey in dangerous cargo manufacturer, and operation procedure visit, train a team with rich experience in on-site supervision of dangerous cargos.

Supervision Measures for Cargo Factors:

1. Strictly control cargo declaration and static approval personnel, and timely deliver physical and chemical properties of dangerous cargos declared to related grid inspection executors;

2. Sort out major dangerous cargos of the port, analyze and conclude their physical

and chemical properties, and share the results with on-site law-enforcement personnel.

4.5.6 Grid of Container Ship

Supervision Measures for Human Factors:

1. Intensify inspection of the crew's practical operation capacity;

2. Intensify inspection of manning and watch-hour;

3. In on-site inspection, intensify inspection of stowage and stability calculation;

4. Check if container ship is equipped with *Convention on Containers* or text of *Specifications of Statutory Inspection* related to internal-trade ships, and if the container tags (CSC) are intact.

Supervision Measures for Ship Factors:

1. Through VIS monitoring, strictly control the speed of container ships entering and leaving port;

2. Conduct statistics of ships with massive container cargos piling up on deck, and VTS watch keepers pay attention to their anchored condition, ship trajectory, and berthing state in strong wind.

Supervision Measures for Environment Factors:

1. Issue early warnings of information of strong wind, big waves and haze weather to ship side with devices like VTS, VHF, etc., to prohibit ships from sailing and leaving port.

Supervision Measures for Management Factors:

1. By means of on-site safety inspection, know well the maintenance plan of container liner and remind companies of preparation in advance;

2. Optimize existing inspection method, strive to purchase scenograph for container inspection, and achieve timely information sharing of dangerous cargo containers obtained by dynamic inspection and static approval.

Supervision Measures for Cargo Factors:

1. Optimize existing methods of unpacking inspection, develop container unpacking and selective inspection software, introduce information such as the resource of customs cargo declaration and electronic packing list of Lianyungang electronic port, automatically verify the name of actual packed cargos and database resource of dangerous cargos, and promote the accuracy of unpacking inspection.

4.5.7 Grid of Small-size Oil Work Ship

Supervision Measures for Human Factors:

1. Strengthen the crew's training and education, and increase their safety awareness;

2. Increase the inspection frequency during the crew's watch-keeping period, and strictly supervise manning and equipment at working site;

3. Increase the on-site inspection frequency of oily water recycling and carry out reminding work.

Supervision Measures for Ship Factors:

1. Strengthen daily inspection and regular safety inspection;

2. Irregularly develop centralized safety inspection.

Supervision Measures for Environment Factors:

1. Strengthen the approval of operating conditions, and timely inform related ships to stop operating in severe weathers such as strong wind and thunder & lightning;

2. Use VTS, etc. to improve weather prediction, carry out early warning in advance, and fully make use of AIS, CCTV and other methods to strengthen the dynamic monitoring of oil water recycling ships.

Supervision Measures for Management Factors:

1. Strengthen source management, and urge ship companies to strengthen the implementation of safety prevention and control measures of on-site operation;

2. Regularly hold meetings and report problems of oil water recycling ships;

3. Investigate management condition of related ship companies.

Supervision Measures for Cargo Factors:

1. Regularly inspect the oil water disposal, and ensure that oil water with low recyclable value hasn’t flowed into the sea.

5 Application of Results

5.1 To Achieve Specific Management of Maritime Field Supervision Model

In reference to different supervision objects, different supervision characteristics and different risk sources in different grids, targeted supervision proposals have been made, which increases the accuracy of maritime supervision.

5.2 To Provide Scientific Tool for further Deepening the Research on Supervision Rules of Some Grid

According to the characteristics of risk sources in grid, the research group divides local on-site grids into 7 typical grid cells, makes use of FSA for risk identification and assessment, and makes resource requirement and targeted proposals, to provide a scientific tool model for further refined research on risk of a specific quay berth in a grid.

5.3 To Achieve the Transformation from Extensive Model to Intensive Model of Maritime Field Supervision

Making use of FSA mechanism to set up rolling database of risk identification in grid to collect risk date is in favor of finding rules, integrating various resources, fully bringing the advantages of information resource into play, and transforming after-event supervision to beforehand prevention and control.

6 Follow-up Work

6.1 Research on One of the Elements Detailing Risk - Accident (Danger) Frequency

The research group studies the potential accident consequence – one of the risk elements. However, due to the insufficient quantitative research on accident

frequency (key time bucket has been researched), in the future, methods such as case investigation, statistic analysis of violations, comprehensive assessment, expert consultation, and accounting record of incident & danger information should be adopted to build database for quantitative statistical analysis, so as to improve the accuracy of risk assessment.

6.2 Optimization of Comprehensive Assessment

How to select the optimal cost-benefit ratio is a process of constant statistical quantization and selection in practice. With non-unique reference standard, experience should be gained in specific application, so as to reach the goal of multi-perspectives assessment, summarization and promotion.

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