

On the Quality Ship System for Safety Inspection

GAO De Yi

Professor, and Vice President, Shanghai Maritime University

1550# Pu Dong Da Dao, 200135, Shanghai, China

gaodeyi@shmtu.edu.cn

Abstract

The purpose of the Quality Ship System is to establish a marine supervising management mechanism that is a combination of punishment and encouragement, positive and negative. In detail, it is to establish an inspection evaluation system, a hierarchical rewards and punishment system based on the innovation of modern controlling theory, by bringing into full play the advantages and functions of the Diagnostic Controlling System, the Trust Controlling System, the Forbidden Zone Controlling System and the Interactive Controlling System, so as to perfect the existing ship safety and supervision system.

In view of this, the essay analyzes the problems in present safety inspections, compares four different management controlling systems, then examines detailed descriptions on the systematic structure and the implement steps of Design of the Quality Ship System and Model for the Ship Safety Control.

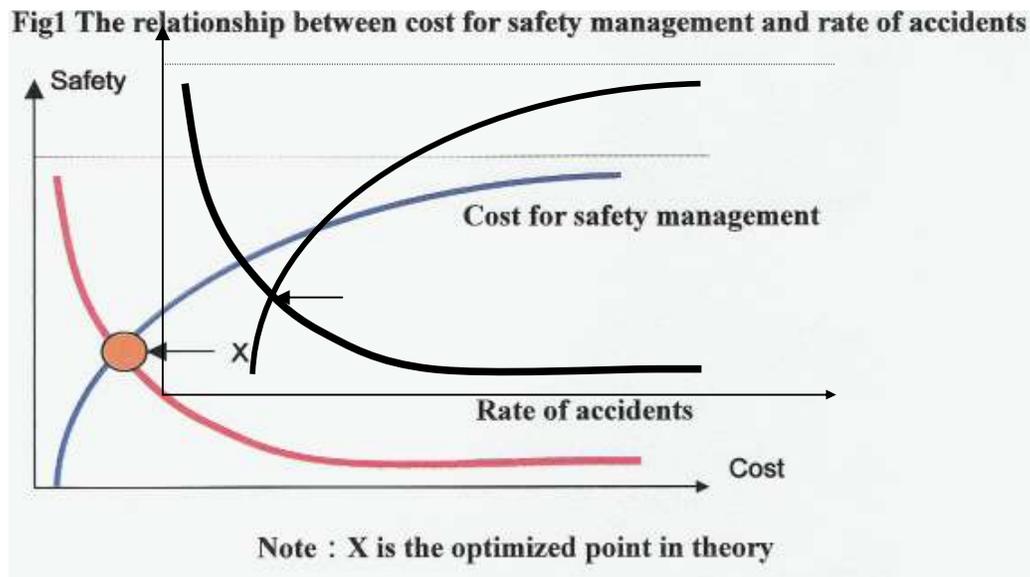
1. Introduction

The severe marine disaster of the Chinese Ro-Ro Ferry in the Bohai Bay in China has not only aroused the astonishment of both domestic and overseas shipping industry, but also brought more concerns on the problems of safety management to Chinese maritime Industry. In recent years, although various measures have been taken by the executive and supervision departments of the Ministry of Communications maritime undertakings in China, maritime safety is far from satisfactory. There still remain many hidden troubles of bottlenecks and disasters. Besides, frequent severe maritime disasters still occur. Tracing its sources, four basic reasons can be identified - the disregard of cognition; the disquieting shipping status; the comparatively low educational level of the staff; and the unsatisfactory management and supervision. Going deep into these four basic safety factors, some important insights can be obtained as follows:

1.1 A frequent mistake in the idealistic realization

The improvement of management calls for the prospective cost, or vice versa, the enhancement of safety management means an increasing cost to meet the needs of the basic assurance of safety. Hence there is a dialectical relationship between safety and cost. The safety of shipping may be reliably assured with the improvement of safety management and the increase of cost. However, the increase of cost does not mean safety follows an invariable linearity. In other words, the increasing cost may never avoid the occurrence of accidents.

Obviously, there is a critical area between safety and cost, i.e., the optimal safety assurance with a reasonable cost. For maritime safety management, it is an optimal conjoined point for relevant governmental authorities, trade supervisors and maritime undertakings to try to find this optimal critical area (See Fig.1). Therefore, it is worthwhile to study how to bring the enthusiasm of these three parties into full play and to exert necessary strong scientific managing methods.



1.2 Less strength and low efficiency of the safety inspections

Statistics shows that in 1999, 903 maritime accidents occurred in China, resulting in direct economic losses of 200 million Chinese Yuan (24 million USD). But how are safety inspections? The following statistics in 1999 can be referred to:

- Ships entering Chinese ports were 381,070, and ships leaving were 381,085.
- Ships that received safety inspections numbered 6,713, which constituted 1.8% of the ships both arriving and departing.
- Ships detained were 74 which made up 0.03% of the ships both arriving and departing

It seems the detention rate is low and the safety status of shipping is not so serious. However, if compared with the serious maritime accidents of over 900 ships, far more than 74 ships have hidden troubles and potential defects.

Probing into the characteristics of the potential defects and the situation of different shipping companies, it can be identified that:

- The main defects are the fire control and life-saving equipment. Next, safety precautions, certificate, pollution prevention, equipment and the loadline, etc.
- Those ships that belong to local or individual companies have more safety defects than those, which belong to national main maritime undertakings.

Several speculations and insights may be drawn from the above analysis:

- Less potency of safety management. On one hand, due to unsatisfactory safety

management, maritime accidents frequently occur. Hence shipping companies should exert more pressure on safety management; On the other hand, the unsatisfactory safety inspection quality enables ships that are not on target to pass the inspection easily.

- Low efficiency of safety management. On one hand, the number of ships engaging in marine transportation is increasing quickly with the rapid development of China's economy. Meanwhile the hidden safety troubles are ubiquitous, which cries for the strengthening of self-construction and external supervision; On the other hand, the limited scale of maritime safety inspections and the linear distribution of inspection results are in a less wide context and of a low proportion. Furthermore, the very same operations without consideration of the previous status of the shipping companies and the safety of the ships cause a low efficiency of safety inspections. The quality of maritime safety management is thus affected.

Accordingly, it is a pressing and arduous task to bring into existence a new virtuous circle of maritime safety management in an environment with limited resources, in order to smoothly develop the national maritime industry and ensure maritime safety.

2. New Ideas on Maritime Safety Management

It is a new problem faced by modern management science and cybernetics, i.e., how to exert enough control in a flexible and innovative environment. For maritime undertakings, this depends on the enthusiasm shown by the shipping managers in the shipping transportation field that may deal with hundreds of millions Yuan. They should try to find opportunities and give reactions to ensure the soundness of both ship and freight thus providing the lowest transport cost and highest transport efficiency. As for the government and supervising organizations, the problem is how to enable the smooth development of maritime safety and the national maritime economy by exercising an active and reasonable administrative and economic leverage.

2.1 Diagnostic Controlling System

Based on the mechanical bureaucratic mechanism, the traditional Diagnostic Controlling System is to avoid the occurrence of accidents by constant supervision, i.e., to ensure the realization of the preconcerted aims by premeditated inspections or inspection processes. For example, the navigating officer on duty should keep the index mark of various devices on the bridge in order to catch sight of any abnormal signs and keep the main manipulated variable under preconcerted control. The other example is that the officers from the Maritime Safety Administration, when carrying out the safety inspection, may take the examination of the differences between the maritime safety standards and the actual conditions of the ship, and may meet the standards by requesting the ship operators to correct the defects. However, this kind of Diagnostic Controlling System is only one side of the coin. The efficiency and intensity of control may be affected in a wider controlling context, numerous controlling factors or a complicated controlling environment. Practices show that Diagnostic Controlling System is not sufficient for efficient control. On the contrary, the execution thereof may cause the failure of environmental control due to the heterogeneous controlling compressive force,

and a crisis may even appear.

2.2 Trust Controlling System

The Trust Controlling System is an active controlling system based on the core-conception which takes advantage of the concise, revelatory, and valuable moral concept and brings into full play the internal impetus and the potential creativity, so as to ensure the orderliness of the organized activity. For example, the maritime supervising organization may encourage maritime undertakings to perform management conforming to safety requirements by establishing a series of policies and regulations. With all these rational policies and regulations, the maritime undertakings try to seek a standard of both safety and efficiency of ship operations and management. Obviously, without the Trust Controlling System, employees cannot understand the kernel of the management and its relative position in a big scale and slack organization. Certainly the Trust Controlling System cannot serve as an independent controlling system, but only as a supplement. However, if displayed rationally, it may play an especially important role.

2.3 Forbidden Zone Controlling System

The Forbidden Zone Controlling System is based on the principle of “Power of Negative Thinking”. The idea of this control is to warn the employees what not to do or there will be severe effects if they do so. Generally, the government tends to establish a set of rules and regulations, which are the frame of the forbidden zone and those who violate the rules will be punished. Standard operation rules and manuals should be set up within the undertakings in order to instruct their employees that what they do could destroy the development and efficiency of the undertakings and what the severe results of safety accidents could be. Different from the Diagnostic Controlling System and the Trust Controlling System, the Forbidden Zone Controlling System is obviously based on the negative effects and the lowest standards. Besides, it adopts punishment as a controlling method. As Prof. Robert Simons from the Harvard Business School said, “...*can never be understood as giving a blank check to the underling and then let them do as they want.*” the Forbidden Zone Controlling System can effectively control those who attempt to dabble with the rules in certain conditions. Practices prove that an organic combination of the Forbidden Zone Controlling System and the Trust Controlling System can create an aggregation of the positive side and the negative side of dynamic pressure, thus creating a bi-directional dynamic pressure mechanism of both stimulus and punishment by the cold, darkness-limited negative pressure.

2.4 Interactive Controlling System

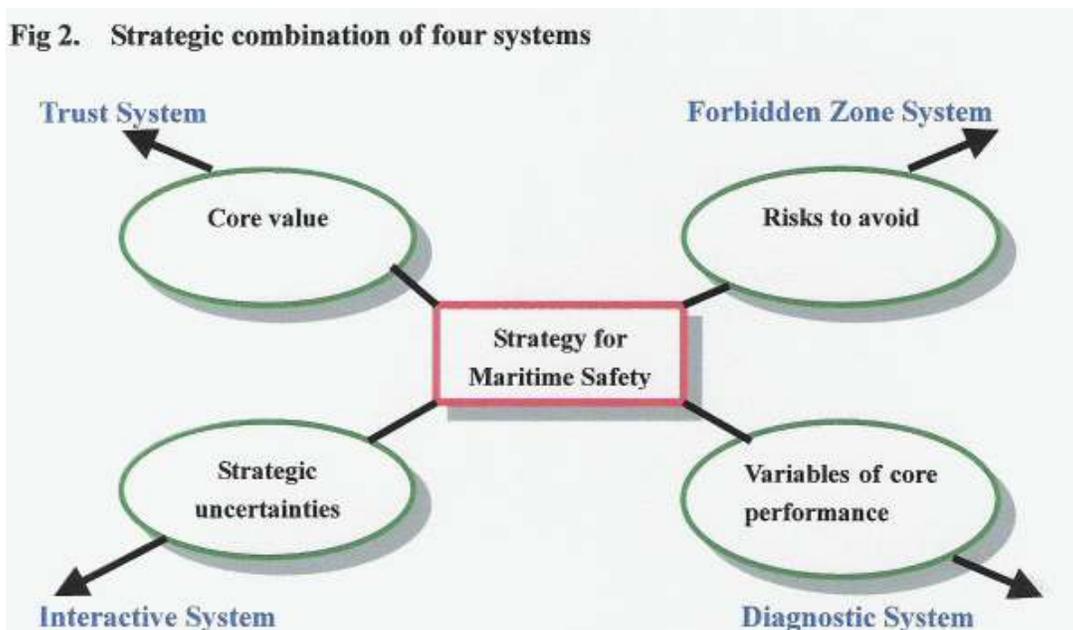
The Interactive Controlling System is an active controlling pattern based on mutual trust, intercommunication, co-action, and co-determination. With the extension of the maritime administration and the reinforcement of such a management, the absence of communication and co-action between the government and the undertakings may make safety management and supervision weak and powerless. The advantages of the Interactive Controlling System over the Diagnostic Controlling System are as follows:

- Various beneficial channels are established to remind the maritime administrators and operators of the undertakings of the new changes taking place in the safety production;

- Thanks to the active environment of co-action, great importance has been attached to the important information by maritime administrations, thus the undertakings may take active methods more voluntary to ensure the safety at sea.
- Co-action communication is helpful for mutual understandings.

On the whole, an organic combination of these four controlling systems will definitely have a remarkable effect: The Diagnostic Controlling System ensures the realization of those important aims by controlling the variables of the core performance effectively. The Trust controlling system, by establishing the core-conception, passes the authority on to the “to be controlled” to encourage operators to self-inspire and innovate in management, thus the object may exert more potential to ensure the realization of the aims. The Forbidden Zone Controlling System avoids accidents and sets up a prediction of punishment by nailing down the rules and regulations. Lastly the Interactive Controlling System is helpful to establish a real information communication and find out the unknown field of the strategic decision-making so as to make appropriate compensation for the uncertainty of the strategy. The relationships between them are as follows:

Fig 2. Strategic combination of four systems



Existing maritime safety management and supervision is based on a combination of the traditional Diagnostic Controlling System and the Forbidden Zone Controlling System. It performed irreplaceable functions in the past. However, despite the efforts of shipping companies and the history of the safety of different ships, using all the same procedural practices and pre-arranged checks will, on the one hand, limit the thoroughness and deepness of the checks. Therefore, it will eliminate as well the activeness of those ships with a good reputation on the safety and operation, and those ships may have the regret of being tied together with those unqualified ships.

3. The Framework of the Quality Ship System

In order to strengthen supervision over the ships in respect of equipment and crewmembers, to ensure the safety of lives and possessions and to avoid the pollution of the sea, the Maritime Safety Administration (MSA) P.R.C established the *Rules on Ship Safety Inspection of PRC (1997)* in light of relevant International Conventions and the relevant clauses incorporated into the Tokyo Memorandum of Understandings (MOU). According to the rules, all the Chinese sea-going ships which have gross tonnage over 200 tons or main engine power over 750kw, inland waterway ships which have gross tonnage over 50 tons or main engine power over 36.8kw, and all foreign ships arriving or departing Chinese ports should receive safety inspections. The maximum frequency of such an inspection is six months, except those passenger ships, ro/ro vessels, bulk ships, crude oil carriers, LPG carriers, chemicals in bulk vessels and other carriers designed and used for special needs. The inspectors of MSA carry out inspections using 16 aspects of the rules. Once defects are found, the inspectors shall take necessary measures; for instance requesting in-port corrections for those defects, or detaining the ship.

Obviously this inspection and supervision system is a combination of the traditional Diagnostic Controlling System and the Forbidden Zone Controlling System. Communication between the inspectors and the party to be inspected is basically inactive and unilateral, from the inspectors to the party to be inspected. In such a system, the party to be inspected will always have a regular tendency of being inspected and lack of enough enthusiasm; and the control or punishment is negative.

The System of Quality Ship is to establish a marine supervising management mechanism that is a combination of punishment and encouragement, of positive and negative. In detail, it is about the establishment of an inspection evaluation system, a hierarchical reward and punishment system based on the innovation of modern controlling theory, by bringing into full play the advantages and functions of the Diagnostic Controlling System, the Trust Controlling System, the Forbidden Zone Controlling System, and the Interactive Controlling System. The existing ship safety and supervision system can thus be promoted.

3.1 The Criteria of Quality Ship

The Quality Ship System means that in a well-functioning shipping company its underling ships are certified to have conformed to the safety standards, to have provided good shipping management records and to have been approved by the maritime supervising organizations. Therefore, the Quality Ship System requires maritime supervising organizations to establish uniform safety standards according to the particular requirements of International Conventions, national maritime laws and regulations and the general public. The following indexes should be taken into account as to how to establish such safety standards:

- During the past three years ships haven't been detained either in a domestic or foreign port by reason of non-conformity to the standards. (The reason why the period should be three years is that it is usually a statistical period in the international supervising and inspection system, and a comparatively long period is helpful for an unfeigned

- inspection of the ship's safety management level.)
- The ship has a good safety management system and has no record of violating the relevant prescriptions concerning maritime transportation safety.
 - No severe marine accident was recorded in the past three years.
 - The sailors have not, as individuals, any records of severe contraventions of safety regulations and other criminal records in the past three years.
 - In the past three years, the shipping company has never appeared in the blacklist of the Port State Control (PSC) inspection, or the detention rate of the company is higher than the average rate of the previous three years.
 - In a certain period of time (e.g. one year), the accumulative integral of the defects inspected in safety inspections does not exceed the stated accumulative integral by the Quality Ship System.

The above-mentioned indexes are all impersonal except the last one, which decides whether it accords with the qualifications. The last index is a variable beta function of integrated safety factors and it must be measured and accumulated by using a normative index system with appropriate weight co-efficiency, so as to take the quantified value out.

3.2 The Evaluation System of the Quality Ship System (Ship Safety Performance and Defect Index System)

The evaluation system of the Quality Ship System may use the hierarchy analytical method of the management study by regarding the above six basic indexes as factors on the first grade. Factors that can be logically estimated should not have the secondary index. As for the sixth index, a secondary index and even a tertiary one should be set in order to fix upon the quantified value. The index system is shown in table-1.

Table-1. The index system of the evaluation system of the Quality Ship on the first grade (Ship Safety Performance and Defect Index System)

A1	Detention of the ship
A2	Violation of the safety rules
A3	Maritime accident
A4	Violation of the safety management regulation as individual
A5	The resort rate of the shipping company
A6	The accumulative integral of defects

The accumulative integral of defects (A6) can be further divided into the secondary and tertiary index according to the needs. According to *The Rules on Safety Inspection, 1997*, 16 secondary indexes can be set. (See table-2) Every secondary index may be followed by relevant tertiary index(C) in order to describe the meanings of the secondary index in details.

Table-2 The secondary indexes

A6	B61 * W61	Ship's certificates and the relevant files and documents
	B62 * W62	Crew and equipment

	B63 * W63	Life-Saving Appliances
	B64 * W64	Fire fighting equipment
	B65 * W65	Presentations against accidents
	B66 * W66	Generic safety precautions
	B67 * W67	Alarm equipment
	B68 * W68	Stowage of goods and loading and unloading equipment
	B69 * W69	Loadline
	B610 * W610	Mooring equipment
	B611 * W611	Propelling and auxiliary machinery
	B612 * W612	Navigation equipment
	B613 * W613	Radio equipment
	B614 * W614	Anti-pollution equipment
	B615 * W615	Loading and unloading equipment of liquid goods
	B616 * W616	Relevant equipment of the post and manipulation ability of the crew

Table-3 The Tertiary indexes

B61	Ship's certificates and the relevant files and documents	C611 * W611	Nationality certificate
		C612 * W612	Copy of DOC
		C613 * W613	Ship's survey certificate
		C614 * W614	Certificate of minimum manning
		C615 * W615	Documents relating to the reliability and insurance of the oil pollution
		C616 * W616	Certificate of safe operation for high speed craft
		C617 * W617	Related documents, manual, instructions and materials
		C618 * W618	Inspection book of the cargo handling facilities
		C619 * W619	Ship endorsements
		C6110 * W6110	Ship Log and legal records

3.3 The Mathematic Model of the Valuation System of Quality Ship

A conclusion can be made from the characteristics of the above indexing system. That is, the valuation system of Quality Ship is a system made by the combination of the logical estimation grade (the first grade index A) and a series of hierarchy distributions (A6). The Quality Ship may be demonstrated by the following formula:

$$QS = \sum A_i$$

The accumulative integral of the defects (A6) may be demonstrated as follows:

$$\begin{aligned}
 A_6 &= B_{61} W_{61} + B_{62} W_{62} + \dots + B_{615} W_{615} + A_{616} W_{616} \\
 &= B_{61} (\sum B_i W_i, \sum C_j W_j) W_1 + B_{62} (\sum B_i W_i, \sum C_j W_j) W_{61} + \dots + B_{615} \\
 &\quad (\sum B_i W_i, \sum C_j W_j) W_{615} + B_{616} (\sum B_i W_i, \sum C_j W_j) W_{616}
 \end{aligned}$$

Notes:

B61...B616 Stands for the secondary index of the accumulative integral of the defects.

C_j Stands for the tertiary index

W_{ij} Stands for the secondary or tertiary weight.

3.4 The Establishment and Application of the Weight of Index

The first five indexes in the first layer can be estimated directly by the accumulated historical data, so it is comparatively easy to get a conclusion. However, the sixth index in the first layer (the accumulative integral of the defects) must be inspected on the spot and reach the conclusion taking the accumulation of the historical data into account. A correct and just inspection is the key-point of defining a quality ship. Practice shows that the three layers of indexes involved by the accumulative integral of the defects is of a contribution to the degree, extension and effectiveness for a given period of time of the safety of ships. Hence it is of significance to define the degree of contribution (i.e. weight coefficient) scientifically and it will be helpful to decide the criteria of Quality Ship accurately.

Generally, the Analytic Hierarchy Process (AHP) can be used to decide the Weight Valuation Index System of a hierarchy, which was first put forward by the American scholar in management, T.L.Saaty (1980). Its basic principle is to establish a matrix by gathering all the factors in the hierarchy and the independent expert will compare one factor with the other according to the nature and characteristics of every factor. The comparison is a relatively important discriminant that is based on the uniform and hierarchised judgment model. The Weight decided by a group of independent experts in order to get the Weight of every factor should be averagely. Once the Weight of the factors on every grade is explicit, all that is required is to type into the computer to get the inspection results of the ship's safety factor.

3.5 The Evaluation Criterion of the Index Value

There must be a fair and objective evaluation criteria for every index value. The national maritime organization has in the past several years established a complete set of inspection rules and criteria of the ship safety factors. And the foundation of the PSC system serves as a base for the establishment of a uniform evaluation criterion. For example, the inspecting procedure of *Tokyo MOU* and *A Handbook of the Safety Inspection of Ships along the Coast* are both valuable normalized models.

3.6 An Assumption of the Application for Quality Ship System

The establishment of the Quality Ship System is a systemic project and the practice work should be based upon justice, clarity and efficiency.

First of all, relevant management rules and regulations should be established by the national maritime organizations in charge. The kernel of the rules and regulations is to establish the Quality Ship System so as to carry out the safety inspection more strictly and the reward and punishment more trenchantly. On the one hand, it can further strengthen the inspection, especially for those ships with an unqualified safety records and a lot of hidden troubles; on the other hand, by carrying out the reward and punishment, it may encourage those shipping companies with good safety records and wholesome management systems to retain top-quality safety management. Those shipping companies conforming to the standards of Quality Ship may get a Quality Ship certificate awarded by a certain national maritime organization. During the period of validity of the certificate, the quality ship may enjoy various favorable policies and treatment.

The quality ships authenticated by the strict evaluation system of Quality Ship may have wide applications. The four controlling levels may bring their functions into full play through the strengthening of the system. As for positive stimulations, at least the following three can be done:

- Publicize in an open publication; for example publish in a newspaper or publicize on the Internet so as to encourage the Quality Ship to persist in good safety management. It has been already done in Europe.
- Trust those ships in the period of validity of the certificate so as to encourage the administrators to take measures to increase the efficiency of safety production.
- Encourage ports to give favorable treatment to the Quality Ship upon arrival, carrying out the operation and other relevant tasks and even provide a preferential price. That favorable treatment has been done in some countries and regions recently.

As for the punishment, those nonstandard ships (once been detained), or ships with a bad safety record or with accumulated defects lower than that of normal ships shall be punished so as to help the shipping company correct the defects. Based on the safety records, the ship's previous inspection notes and the accumulated integral defects, the following measures may be put into effect:

- Circulate a notice of criticism as a kind of warning for those ships.
- Increase the frequency of inspection, following a strict verification and monitoring in the network;
- Place necessary restrictive measures on the marine navigation;
- Institute necessary economic punishments.

4. The National Examiner System for Maritime Safety

The realization of the Quality Ship System calls for a group of examiners of high accomplishment who may conduct the inspection impersonally and justly. The construction of the maritime tipstaff should not only strengthen the leadership and management but also concentrate efforts on rules and regulations. China should construct a group of specialized maritime examiners of high accomplishment by using the popular international practices for reference. A national maritime examination system should be established through legislation and the establishment of relevant laws and regulations. These regulations nail down the education and training of the examiners, professional standards, the retraining system, the method of examination and the awarding of certificates. In the concrete, the maritime examiners should receive strict training recognized by the national government. The professional standards mean that the examiners should be competent for every professional level concerning the maritime inspections. For instance, necessary professional knowledge, experience at sea, practices of maritime inspection and upstanding professional ethics. The qualification of holding an office should be conferred through a special authorization procedure, thus the examiner may get a certificate of competence of maritime examiners. As for the management of the maritime examiners, firstly there should be a timely refreshment of knowledge and improvement of ability. Secondly, there should be a strict set of management systems including measures of reward and punishment.

5. The feasibility of the Quality Ship System and its Possible Problems

Although the Quality Ship System is a huge systematic Engineering, it is feasible with the establishment of China's maritime management system and its managing group with high ability, as well as improvement in the safety management of shipping undertakings.

The establishment of the Quality Ship System calls for the accumulation, transaction and exchange of a great amount of safety data. The data processing of computers and the development of modern communication technologies create the basic conditions for the establishment of the Quality Ship System.

The establishment and development of PSC system form an international recognizing index connotation for the establishment of the ideal model of the Quality Ship System, thus providing a universal criteria and evaluation method for the objective and just evaluation of the safety condition of ships.

The Quality Ship System should be constructed on the basis of a group of maritime examiners with comparatively high managerial ability. Therefore, the establishment of a group of maritime examiners with high accomplishment is not only the need of the national maritime safety management, but also necessary to create foundations for the establishment of a Quality Ship System.

According to the requirement of the "*Year of Safety Management of Marine Transport*" put forward by the Ministry of Communications, this is suggested to enhance the science and validity of maritime safety management. The Quality Ship System is an important embodiment of the science and validity of the maritime safety management. The Quality Ship System may be not only carried out on the ocean-going vessels, and also then extended to coastal and inland water vessels. Meanwhile, evaluating the experiences and lessons constantly is required to perfect the Quality Ship System.

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