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Method on performance evaluation for FSC

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Method on Performance Evaluation
For FSC

By

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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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TABLE OF CONTENTS

ABSTRACT

Title of Research Paper: **Method on Performance Evaluation for FSC**

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Ship safety is always the top issue in the International Maritime Organization (IMO). Flag State Control (FSC) is the first line to guarantee navigation safety. Along with the implementation of the mandatory IMO Member State Audit Scheme, the performance evaluation regime for flag States has aroused the maritime industry's attention. The performance of FSC is involved in the audit. However, there are always regulations and guidance on FSC inspection, but no evaluation methods on it.

Therefore, in order to evaluate the objective and comprehensive performance of FSC for better result in the IMO audit, in this paper, by using system engineering analysis, questionnaire survey and acquiring the expert's opinions, the author proposes a new method – the "Red, Yellow and Green list" on the FSC performance evaluation based on the previous studies and data verification. All the factors have been carefully analysed and their weighting points in the RYG-list have been given by the experts' assignment. Through applying the inspection data published by China Maritime Safety Administration (China MSA) and consulting the experts, it shows that the RYG-list is feasible and reasonable.

KEY WORDS: Flag State Control (FSC), Performance Evaluation, Red/Yellow/Green List (RYG-list)

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

BRB	Belief Rule-Base
D	Data Records/Database
FSC	Flag State Control
FSCO	Flag State Control Officer
III Code	IMO Implementation Instruments Code
IMO	International Maritime Organization
IMSAS	IMO Member State Audit Scheme
MOT	Ministry of Transport
MOU	Memorandum of Understanding
MSA	Maritime Safety Administration
NIR	New Inspection Regime
NL	National Legislation
O	Overview
PAQ	Pre-Audit Questionnaire
PI	Performance Indicator
PSC	Port State Control
QP	Qualified Personnel
QS	Quality System
RO	Recognized Organization
RS	Range Sufficiency
RYG-list	Red, Yellow and Green List
USCG	United States' Coast Guard
WGB-list	White, Grey and Black List
WP	Working Procedures

Chapter 1 Introduction

1.1 Background

Shipping, responsible for 90 percent of the cargo transport in the world, is a vital component contributing to the world economy (LR, 2015). Ships act as the means of transport, whose safety and seaworthiness are the top event to all the stakeholders in the maritime industry. As the high accident frequency appeared since the 1980s, which seriously endangers human life and marine environment, the International Maritime Organization (IMO) proposed the triple responsibilities: the IMO shall be responsible for setting standards, the flag States for the implementation of the standards and the port States for the standards' inspection and supervision, with the aim of driving the substandard ships out of the shipping market (Zhang, 2017).

The Flag State Control (FSC) is a very important measure to guarantee the ships' navigation safety, which is called the first line of defence to eliminate the substandard ships all around the world. Normally, different countries have different standards for the FSC inspection, but they did not pay much attention on their performance because the IMO Convention did not contain any provision that gives the Organization a monitoring role at first. With the drive of greater transparency and accountability, it has often been said that IMO needs teeth to ensure compliance, but how to achieve this has been emerging gradually. Therefore, a cooperative strategy had to be developed for States to accept a monitoring regime through IMO. After 2016, the IMO Member State Audit Scheme became mandatory instead of being voluntary and all the Parties need to comply with the requirements of IMO Implementation Instruments Code (III Code) for its mandatory audit (Hesse, 2017).

In terms of the strict audit requirements on flag States, how well the FSC inspection as one of assessment aspects has been performed needs to be assessed by some scientific means. Unfortunately, there is no FSC performance evaluation method currently.

1.2 Objective

After reviewing previous literatures, there is no study on how to assess the performance of FSC, but most of which are on how to perform FSC inspections rather than supervise FSC. Therefore, this paper means to propose a new method based on the data from MOUs and FSC inspections of China to assess the performance of FSC for better implementation of the obligations of flag States.

To make the navigation safer and the marine environment clearer is always the aim of all the participants of the whole maritime industry (Du, 2018). By establishing a better FSC performance evaluation system coordinating with the mandatory IMO Member State Audit, China or any audited State will be fully prepared and improve the duty performance as a flag State much better, which is beneficial to not only the safety of ships, but also the reputation and influence of the country in the maritime world.

1.3 Methodology

Literature study is one of the ways used in this paper, which includes IMO instruments, relative websites, books and articles related with FSC history and development, a series of researches about the effectiveness of FSC, some similar

performance assessment systems, annual reports from relative organizations, etc. All of these are trying to draw a whole picture of FSC, including the achievements and drawbacks, introducing the relative research methods and preparing for the further research.

System engineering method is used for analysing all the key factors related to FSC performance. A lot of equations are produced for calculating the indicators' final score to determine the flag State's performance level. Questionnaire survey to experts is used for getting the weighting points of each index. The random sampling and group controlling ways are utilized in the process of verifying the rationality and feasibility of the new method on FSC performance evaluation.

1.4 Structure

The whole paper consists of six chapters. Chapter 1 introduces the background, objective, methodology and structure of the paper. Chapter 2 reviews the history of FSC and its current situation, and also analyses its achievement and deficiencies. Besides, relative performance evaluation mechanisms are listed and discussed in this chapter. Chapter 3 analyses the key evaluation factors for FSC. Chapter 4 tries to establish the method for FSC performance evaluation – the "Red, Yellow and Green List" which has been verified and discussed in Chapter 5. Then, Chapter 6 summarised the whole research paper as a conclusion.

Chapter 2 Literature Review

FSC is an important measure for safety at sea. Knowledge on FSC's history, achievements, defects and relative evaluation systems have been compiled and presented in this chapter, which provides the reference to the main aim of this paper.

2.1 The History of FSC

Since the 1980s, the maritime accident appeared frequently, which seriously endangers safety of human life and marine environment, drawing the attention of IMO and maritime authorities around the world. IMO then proposed the triple responsibilities: the IMO shall be responsible for setting standards, the flag States for the implementation of the standards and the port States for the standards' inspection and supervision, with the aim of driving the substandard ships out of the shipping market (Zhang, 2017).

2.2 The Current Situation of FSC

The inspection content of FSC is basically consistent with the internal and external audits of SMS, covering the inspection items of Port State Control (PSC), based on the flag State's national legislation. The inspection time is usually one to three days or during the voyage from one port to another. The main inspection consists of the management system, the document system, the certificates of the crew, the manning certificate, working and living conditions of the crew, etc. Some FSCOs will check whether the official language of the flag State is used in the engine log, oil record book, the working language and computers, etc. Others will check the equipment,

PMS implementation, engine room hygiene, crew accommodation, sanitary fixtures and sanitary water, etc. (Behnam & Faust, 2003)

2.2.1 The Achievement of FSC

The inspections made by FSC in most of the States become stricter now than years before. Because of the awareness of the importance of the safety and environment protection, a lot of stringent requirements are proposed and need to be faithfully implemented (Zhu & Pan, 2012). As a result, the performance of FSC has been seen improved significantly. Thanks to the IMO Member State Audit Scheme (IMSAS), the New Inspection Regime (NIR) and the WGB-list put forward by the Paris MOU, almost all the flag States pay high attention to the FSC inspection of ships flying their flags to avoid being listed in the black list and affecting their good reputations. Figure 1, 2 and 3 show the increase of the FSC performance reflected by PSC data.
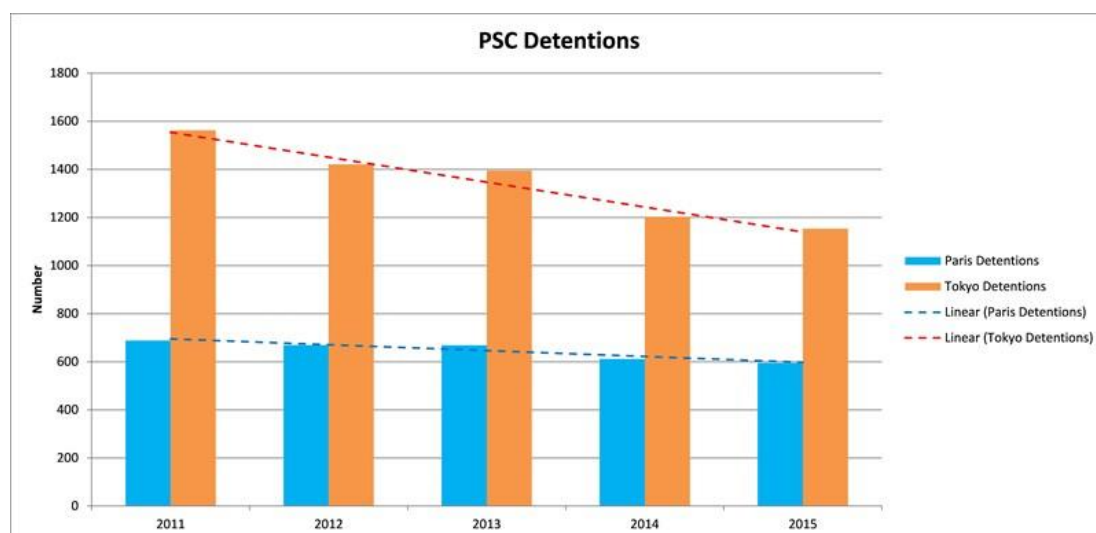
Figure 1 Paris MOU and Tokyo MOU Detentions 2011 – 2015

Source: Hellenic. (2017). *Port State Control Annual Reports Show Improvements for 2015*.
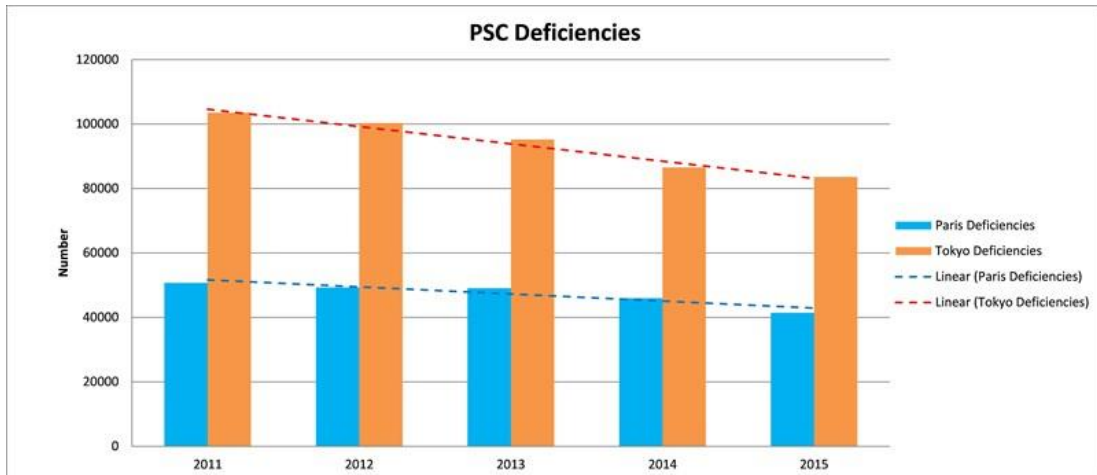
Figure 2 Paris MOU and Tokyo MOU Deficiencies 2011 – 2015

Source: Hellenic. (2017). *Port State Control Annual Reports Show Improvements for 2015*.
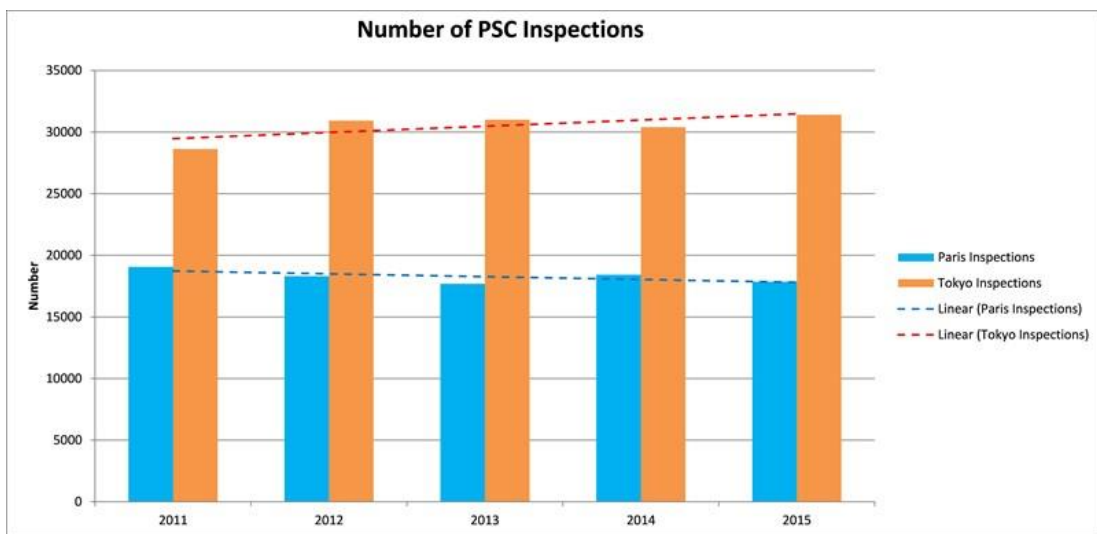
Figure 3 Paris MOU and Tokyo MOU Number of PSC Inspections 2011 – 2015

Source: Hellenic. (2017). *Port State Control Annual Reports Show Improvements for 2015*.

Take China as an example. In 1990s, with the policy of reform and opening up, China's economy grew rapidly. As a result, the merchant fleet of China extended continuously. As the vessels' age was old, the ship management, the quality of the

crew and the ship safety were poor, Chinese flag ships were detained in a high rate by the foreign PSCOs (Z. Zhang & W. Zhang, 2008). From 1994 to 1996, China was listed in the black list by Paris MOU, Tokyo MOU and USCG. Therefore, Chinese ships have to be inspected strictly and frequently, which was seriously affected the competition of Chinese fleet and the reputation of China, the great power country in shipping (Guo, 2013).

To reverse the passive situation, in 1997, the Ministry of Transport (MOT) held the owners of international routes congress to study the problem of high detention rate of Chinese vessels in overseas PSC inspections and propose measures should be taken. The aim of "one year for results, and three years for change" was put forward, for declining the detention rate and getting out of the black list of Chinese ships. Subsequently, China Maritime Safety Administration launched the system of safety inspection before sailing, detention cases study, and the flag State quality comprehensive management. After years of efforts, China was eventually released from the blacklist, and kept standing in the whitelist of each regional MOU, which improves the international image of China greatly (Zhou, 2006).

2.2.2 The Defects of FSC

As the inspections are conducted by people, they are inevitable to be interfered by external and internal factors, such as the various degrees of rigour in inspections, the different levels of the FSCOs' professional competence, bribery, etc.

2.2.2.1 The Various Degrees of Rigour in Inspections

There is a minimum line for FSCOs and the ships to comply with, which is called the minimum standard. Generally, if the ship satisfies all the minimum standards, it is regarded seaworthy and can pass the inspection successfully (Ma & Luo, 2007). However, the standards are made by people and may be interpreted in different ways by different people. If the interpretations of the same standard are not unified, it can cause different requirements on ships inspection. Although there is compiled interpretation published after certain time, it is not proactive to prevent the doubt (Yu, 2009).

2.2.2.2 The Different Levels of the FSCOs' Professional Competence

Training standards are the same to all the trainers, but the learning ability and understanding are different for every FSCO (Yu, 2010). Also, the years' accumulated experience in the field is a vital factor to tell the competence differences of FSCOs.

For example, it is obvious that almost all the green hands in FSC inspection cannot be as competitive as those performing FSC inspections for hundreds of thousands of times. Supposed that the inspection was done by the new comers instead of the experienced ones, it is extremely likely that the ships will be detained wrongly or be judged as zero deficiencies, which is harmful to the ship's safety (Ung, Tsai & Chen, 2013). As the complaint system has become refined gradually, once the captain, whose ship was detained by mistake, complains to maritime authorities or relative administrations, the FSCO performed that inspection would be affected to some degree.

2.2.2.3 Bribery (Corruption)

Like Lord Acton written in *Essays on Freedom and Power*, "Power tends to corruption; absolute power corrupts absolutely" (Acton, 2013). As the FSCOs are designated great power on ship inspections, corruption is the issue of necessity attaching to it.

If a ship with deficiencies does not want to be detained or fined by FSCOs, there is a way that the master just put some money in the FSCOs' pockets, and then, the officers may go through the motions and let the ship go, leaving the deficiencies without remedy. On the contrary, if the qualified ship is inspected by greedy FSCOs, they may create all sorts of obstacles and find faults deliberately, which implies that the ship master must bribe the FSCOs to exchange for the ship's normal departure from the port. According to the interviews with 100 captains by telephone randomly, about 91 percent of them acclaimed that they encountered the problem of corruption in different degrees in spite of caring about whether the ship is seaworthy or not.

It is obvious that corruption of the FSCOs will greatly affect the safety of the ships and hinder the pace of eliminating the substandard ships out of the market. Although there is the complaint system operating to protect the administrative counterparty's rights, actually, they are afraid of being revenged by the FSCOs performing the inspections. Besides, the income of FSCOs is lower and the reward regime is not refined to promote the FSCOs to devote themselves to the divine work. Therefore, taking advantage of their position to get extra money is inevitable. Once they cannot be supervised and controlled, the corruption phenomenon will continue being the factor affecting the ships' safety.

2.3 The Current Performance Regimes

2.3.1 White, Grey and Black List for Flag States Performance

Port state control is recognised as the second line to protect ships' safety due to its role of supplement and supervision of flag States (Knapp & Franses, 2008; Knapp, Bijwaard & Heij, 2011). Therefore, how well the flag fleets have performed can be judged by the results of PSC inspection. Table 1 is an example to show the flag States' performance level.

Table 1 Port State Inspections per Flag (Extract)

Flag	No. of inspections	No. of inspections with deficiencies	No. of deficiencies	No. of detentions	Detention percentage %
Antigua and Barbuda	374	202	674	4	1.07
Argentina	2	2	5	0	0
Australia	13	1	6	0	0
Bahamas	757	354	1,320	17	2.25
Bahrain	2	1	17	1	50.00
Bangladesh	52	43	190	2	3.85
Barbados	19	12	42	3	15.79
Belgium	30	13	41	0	0
Belize	876	820	4,474	54	6.16
Bermuda (UK)	69	12	20	0	0
Brazil	7	5	19	0	0
Brunei Darussalam	6	3	19	0	0
Cambodia	2	2	6	0	0
Cayman Islands (UK)	117	31	93	0	0
Chile	10	5	16	0	0
China	543	275	1,094	1	0.18

Source: Tokyo. (2018). *Annual report on Port State Control in the Asia-pacific region 2017*. Tokyo: The Tokyo MOU Secretariat.

The topic of measuring flag State performance, the "White, Grey and Black (WGB) List", was first introduced by the oldest PSC regime, Paris MOU and was later adopted by Tokyo MOU (M. Perepelkin, Knnapp, G. Perepelkin & Pooter, 2010).

This performance list is annually published and compiled by a given means, classifying the performance of flag States into three categories – white, grey and black, where presents the full spectrum, from quality flags (white list) to flags with a poor performance that are considered high or very high risk (black list). It is based on the total number of inspections and detentions over a 3-year rolling period for flags with at least 30 inspections in the period (Paris MOU, 2017). The current method in force is displayed in Equation 2a and 2b. Appendix 1 respectively displays the white, grey and black list of 2016 published by Paris MOU.

$$u_{blacktogrey} = Np + 0.5 + z\sqrt{(Np(1-p))} \qquad (2a)$$

$$u_{greytowhite} = Np - 0.5 - z\sqrt{(Np(1-p))} \qquad (2b)$$

When the WGB-list was introduced to the maritime world, it has been seen as the baseline to measure flag States' performance in spite of its regional application. However, there are main drawbacks of the list. Some experts point out that it is unable to handle small sample sizes (less than 30) and inaccurate approximation, uses biased samples and omits some critical types of factors such as maritime incidents when determining the performance of flag States, which needs to be revised and refined for integrity (M. Perepelkin, Knnapp, G. Perepelkin & Pooter, 2010).

2.3.2 IMO Member State Audit Scheme

Because the IMO Convention did not contain any provision that gives the Organization an enforcement and monitoring role at first, with the drive of greater transparency and accountability, it has often been said that IMO needs teeth to ensure compliance. Therefore, a cooperative strategy had to be developed for States to accept a monitoring regime through IMO (Hesse, 2017). In 2013, IMO's 28th Assembly meeting adopts new Instruments Implementation Code (III Code), paving

the way for the scheme to be mandatory by 1 January 2016 with the aim of determining the extent to which they give full and complete effect to their obligations and responsibilities contained in a number of IMO treaty instruments. The mandatory IMO instruments included in the scope of the Scheme cover safety of life at sea (SOLAS 1974 and its 1988 Protocol); prevention of pollution from ships (MARPOL); standards of training, certification and watchkeeping for seafarers (STCW 1978); load lines (LL 66 and its 1988 Protocol); tonnage measurement of ships (Tonnage 1969); and regulations for preventing collisions at sea (COLREG 1972) (IMO, 2018).

This audit means to get an objective overview on all the Member States' implementation by assessing their performance as flag, port and coastal States under IMO instruments. In other words, it is an effective way to push them to do their jobs fully. For instance, written in III Code, flag States should fulfil the requirements of implementation, delegation of authority, enforcement, investigations, evaluation and review, etc. (IMO, 2013) The result may affect the Member State's reputation and fleet in the maritime industry, which should be pay much attention on.

2.3.3 IMO Performance Indicators

In 2017, the Strategic Plan for the Organization for the six-year period 2018 to 2023 (Resolution A .1110(30)) was adopted by the IMO Assembly, in which it set out the performance indicators for measuring the Organization's performance against the strategic directions, which are listed as the followings (IMO, 2017):

- SD 1 Improve implementation
- SD 2 Integrate new and advancing technologies in the regulatory framework

- SD 3 Respond to climate change

- SD 4 Engage in ocean governance

- SD 5 Enhance global facilitation and security of international trade

- SD 6 Ensure regulatory effectiveness

- SD 7 Ensure organizational effectiveness

All of the 40 performance indicators (PIs) have been shown in Appendix 2, which can be used to assess how effective the Organization has worked. The comprehensive performance evaluation regime can be referenced when setting up the FSC performance evaluation system.

2.3.4 Safety Management Performance Assessment for MSA

China and Norway jointly conducted the assessment on MSA performance in term of safety with Belief Rule-base (BRB) methodology (J. F. Zhang, Yan, D. Zhang, Haugen & Yang, 2014). It proposed the referable way for the FSC performance evaluation regime - experts' knowledge collected by questionnaires on the weight distribution of various factors which are fallen into two groups: safety situation and cost. Figure 4 presents the framework in the thesis for MSA performance assessment.
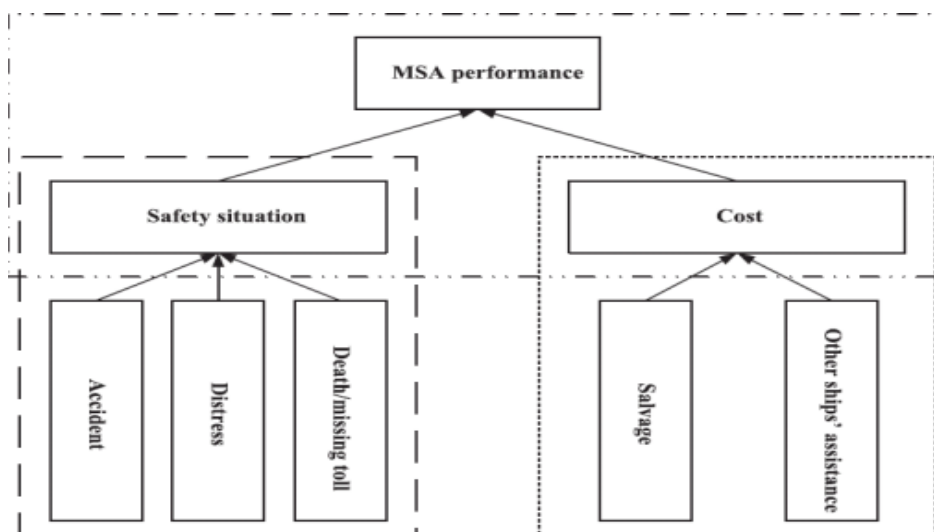
Figure 4 The Framework on MSA Performance Assessment

Source: Zhang, J. F., Yan, X. P., Zhang, D., Haugen, S., & Yang, X. (2014). Safety management performance assessment for Maritime Safety Administration (MSA) by using generalized belief rule base methodology. *Safety Science, 63*, 157-167.

Viewed from the whole thesis, the factors were not so complete. Besides, lacking previous referable data, economic loss, pollution, etc. were excluded. As a result, it cannot be recognised as a thorough study on MSA's performance. Nevertheless, acquiring experts' knowledge to assign weights on different factors is practical and meaningful for the further research on the establishment of FSC performance evaluation system.

2.3.5 QUALSHIP 21 of USCG

The Coast Guard efforts to eliminate substandard shipping have focused on improving methods to identify poor-quality vessels (targeting schemes). However, regardless of the score that a vessel receives in the targeting matrix, all foreign-flagged vessels are examined no less than once each year. This provides few incentives for the quality ships. Hundreds of thousands of vessels are operated responsibly, and are typically found with a few or no deficiencies. Under current policies, these vessels are boarded at similar intervals no matter whether they are operated responsibly or not. However, these quality vessels should be recognized and rewarded for their commitment to safety and quality. Therefore, the Coast Guard has performed an initiative method, which is called Qualship 21.

The Coast Guard publishes the 3-year rolling detention rate of each flag State in the annual report every year. If a flag State's 3-years rolling detention rate is higher than the average, the value of risk factors will increase, and the flag's fleet will be subject to a priority inspection level. In addition, one of the critical criteria of Qualship 21 evaluation requires vessels to be registered with a Flag Administration that has a detention ratio less than or equal to 1.0%, determined on a 3-year rolling average, and the flag State must pass through the voluntary IMO member state audit, which is a strict system. It also provides incentives for the qualified ships, such as issuing certification, reducing inspection times, publishing the names of ships on its website, etc. To be on the list of Qualship 21 is the aim of flag States, Recognized Organizations (ROs) and shipping companies all around the world (USCG, 2012).

2.3.6 New Inspection Regime

New Inspection Regime (NIR) is a system set for selecting suitable target ships for inspection. This new regime evaluates the ships from many aspects with different weighting point, including ship type, ship age, flag, RO and company performance, deficiencies and detentions, etc. Together calculated by certain criteria, we can know the risk level of ships to determine which needs to be inspected. However, the standard of the weighting point is different between Paris MOU and Tokyo MOU (Zhang, 2017).

It is a good way to evaluate targeting ships due to the comprehensive and objective results. However, there is no direct relationship with mandatory IMO member state audit now; that is to say that the regime is not supervised properly. If a corruptive PSCO threatened a ship master via issuing more deficiencies, the number of

detention and deficiencies will increase deliberately because one weighting point is equal to five or more deficiencies.

2.4 Summary

This chapter has reviewed the history, development and achievements of FSC, which indeed devotes to the safety situation at sea. It has also uncovered the defects including rigour difference, the FSCOs' different professional competence and corruption, which is waiting to be solved in order not to affect the safety of ships. Then, the relative evaluation regimes such as the White, Grey and Black List, IMO Member State Audit Scheme, IMO Performance Indicators, Safety Management Performance Assessment for MSA, QUALSHIP 21 of USCG, and the new inspection regime for selecting targeting ships for inspections. With advantages and disadvantages, all of them are worth being referred to in establishing a new performance evaluation regime for FSC.

Chapter 3 Key Factors Analysis in FSC Performance Evaluation

To establish the FSC performance evaluation model, it is important to analyze the key factors composing the method. In this chapter, the analysis of three major categories of elements has been done, which can affect the performance evaluation in different aspects.

3.1 Critical Elements

The static resource indicators, dynamic implementation indicators and supervision indicators are three major categories interpreted in the following paragraphs, which are significant to build up the evaluation model.

3.1.1 Static Resource Indicators

As IMO Member State Audit Scheme should be implemented mandatorily, the pre-audit questionnaire (PAQ) should be filled duly, clearly and concisely to show the State implementation of the applicable IMO instruments. As a result, the contents related to FSC involved in the PAQ should be summarized as the static resource indicators to evaluate the performance of the flag State. Table 2 gives a clear layout of these indicators.

• Range sufficiency (RS). To fulfil the duty, each State should ensure that FSC stations have been located at every port where there are commercial ships sailing in and out. Hence, the coverage of FSC for all the needy regions in the member state should be considered at first.

•National Legislation (NL). As III Code required, international conventions and regulations should be transferred into national legislations and policies for the

responsibility implementing. This is the basis to guarantee the legislative inspection of FSC.

· Quality System (QS). The quality system is the work reference of the FSC section. Relative documents or records need to be reviewed to evaluate the system's running situation.

· Working Procedures (WP). The FSC inspection procedures regulated should be set up rationally and implemented strictly.

· Qualified Personnel (QP). The recruitment criteria and periodical training for qualified FSCOs should be assessed.

· Data Records/Database (D). The inspection data compiled and released by annual report of competent authorities can reflect the performance of FSC. It also provide the horizontal comparison with other regions.

· Overview (O). The FSCOs should conduct the post-evaluation every year to summarize experiences and set up new goals for next phase.

Table 2 Static Resource Indicators

1	Range sufficiency (RS)
2	National Legislation (NL)
3	Quality System (QS)
4	Working Procedures (WP)
5	Qualified Personnel (QP)
6	Data Records/Database (D)
7	Overview (O)

Source：Summarized by the Author. (2018).

3.1.2 Dynamic Implementation Indicators

To inspect ships duly and to detain ships violating the regulations violently are the holy responsibilities of FSCOs in every State. For FSC, the total inspection number, the detention number, the detention rate, deficiency number and the number of deficiencies per ship are the traditional assessment indicators shown in the annual report to indicate the FSC performance directly. Referring to the NIR and IMO performance indicators, in addition to the detention rate, the number of deficiencies per ship and the deficiency rate can be contained in the dynamic implementation indicators.

The detention rate and the deficiency rate can reflect the stringency and competency of FSCOs. If they are stricter, more detentions and deficiencies can be found, so the rates will be high, and vice versa. The number of deficiencies per ship can indicate the ship condition and efforts of FSCOs, which can be used to verify the detention rate and the deficiency rate. It is impossible that the number of deficiencies per ship is small while the detention rate and the deficiency rate are very high.

Therefore, by adding these indicators, the performance evaluation result of FSC will be objective and comprehensive.

3.1.3 Supervision Indicators

In this part, the casualties and the number of effective complaint should be contained in the performance indicators.

3.1.3.1 Casualties

Maritime casualty investigation is also an important link point to the whole chain of marine safety. Incidents are inevitable when navigating at sea, which will not endanger people's life seriously, so casualties with fatal consequences relating to the FSC inspections should be involved as a critical indicator for the more impartial and comprehensive results.

Already by June, 2007, the Turkish Government, based on the academic studies, proposed the risk assessment comparison between the maritime casualties and Port State Control inspections in Europe. It argued that the statistical data of the PSC inspection should not be used as the only ship risk assessment standard. In addition to the factor of PSC inspection, maritime casualties should also be considered. The comparison between the maritime accidents rate and the detention rate of PSC inspections in Europe between 1998 and 2002 confirmed their affirmation. The statistics indicate that the casualties and PSC retention rate is not a positive correlation. Even such serious accidents like ERIKA and PRESTIGE happened, two ships' flag States and classification societies did not appear in the blacklist of Paris MOU (Turkey, 2007). The characteristic of FSC is quite similar to that of PSC. In the same way, for FSC performance evaluation system, the casualties should be considered.

3.1.3.2 Effective Complaint Number

Complaint is the other indicator. It is a new and extensive measure for ship owners and shipping companies to make complaints about the unfair or wrong deficiencies and detentions performed by the FSCOs. It is also a chance for them to let their voice

heard. Actually, the flag State is the rule maker to deal with complaints. All the procedures are implemented by MSA or maritime authorities, where the FSCOs work. As a result, although the complaint can be anonymous, the shippers are still afraid of being revenged because there must be some important objective information left, such as the ship name, inspection time, etc. Few real legal actions are taken by them. Besides worrying about being revenged, there is another scenario that the ship masters or shipping companies revenge the FSCOs deliberately. For instance, in China, the government pays more attention on the complaint from the public about the faults or unfair treatment of the civil servants. No matter the servant is wrong or not, if there is a complaint about him or her, it will be recognized that he or she should be blamed for the complaint, which will affect his or her performance assessment, even promotion and future. As a result, if the revenge by complaints occurs, the clean FSCOs will be affected to some extent, so these types of complaints are not fair and should be omitted when assessing the performance of FSC.

The complaint number must be real and effective and none of the two conditions is dispensable, or the indicator will not be objective and impartial, which is no help for the evaluation system.

3.2 Aggregation of All the Indicators

As mentioned in section 3.1, all the indicators involved in the FSC performance evaluation are shown in Figure 5, which is the prototype of the evaluation system.

Static Resource Indicators	Dynamic Implementation Indicators	Supervision Indicators
• Range Sufficiency • National Legislation • Quality System • Working Procedures • Qualified Personnel • Data Records/Database • Overview	• Detention Rate • Deficiency Rate • Number of Deficiencies per Inspection	• Casualties • Effective Complaint Number

Figure 5 The Prototype of FSC Performance Evaluation System

Source: Drawn by the Author. (2018).

3.3 Summary

There are three major categories – the static resource indicators, dynamic implementation indicators and supervision indicators, which can be used to evaluate the FSC performance. Among each major indicator, there are seven, three and two detailed indicators respectively. All the 12 detailed factors have been analyzed and determined to affect the results of the performance evaluation. Therefore, a prototype of FSC performance evaluation system has been built up finally.

Chapter 4 The New Method of FSC Performance Evaluation
– Red, Yellow and Green List (RYG-list)

The prototype of the evaluation system has been built up in Chapter 3. To make it run is the final aim of the method. Therefore, in this chapter, the assignment and quantitative scoring measures on each indicator will be introduced to achieve the intact model of the FSC performance evaluation system.

4.1 Assignment of Values for the Prototype

The assignment is completed by requiring the experts' views on the weighting point of each indicator and possessing those information to determine the final distribution of indicators.

For getting experts' opinions on the prototype assignment, the author has consulted 30 experts by questionnaire, among whom, 14 are senior FSCOs from 14 MSA in China with over 5-year FSC working experience, 3 auditors with the experience of the IMO Member State Audit, 6 captions working onboard more than 10 years, 4 managers relating to the fleet management in shipping companies and 3 professors from maritime universities.

The total mark of all the indicators is 19 points. By collecting the questionnaire (displayed in Appendix 3), discussing with them to resolve the differences among their results, after calculation, the final unified distribution of the weighting points are summarized in Table 3, 4, 5 and 6.

Table 3 The Distribution of the Three Major Components

Category	Static Resource Indicators	Dynamic Implementation Indicators	Supervision Indicators
Point	7	10	3

Source: Drawn by the Author. (2018).

Table 4 The Distribution of Static Resource Indicators

Category	Range Sufficiency (RS)	National Legislation (NL)	Quality System (QS)	Working Procedures (WP)
Point	1	1	1	1
Category	Qualified Personnel (QP)	Data (D)	Overview (O)	
Point	1	1	1	

Source: Drawn by the Author. (2018).

Table 5 The Distribution of Dynamic Implementation Indicators

Category	A (Good)	B (Intermediate)	C (Poor)
Point	10	5	0

Source: Drawn by the Author. (2018).

Table 6 The Distribution of Supervision Indicators

Category	Casualties	Effective Complaint Number
Point	1	1

Source: Drawn by the Author. (2018).

4.2 Quantitative Scoring Measures on All the Indicators

Concentrating all the indicators' weighting points in a whole can be used as the scoring table for the performance evaluation in a quantitative way. Table 7 is the synthesis of Table 3, 4, 5 and 6, representing the final scoring table of the new model named as the "Red, Yellow and Green List" (RYG-list).

Table 7 The Final Scoring Table of the RYG-list

Name of MSA		Final Score	
Category	Detailed Indicators	Point	Actual Score
Static Resource Indicator	Range Sufficiency	1	
	National Legislation	1	
	Quality System	1	
	Working Procedures	1	
	Qualified Personnel	1	
	Data Records/Database	1	
	Overview	1	
Dynamic Implementation Indicator	A (Good)	10	
	B (Intermediate)	5	
	C (Poor)	0	
Supervision Indicator	Casualties	1	
	Effective Complaint Number	1	
Full Mark		19	——

Source: Drawn by the Author. (2018).

Synthesizing the experts' opinions, each detailed indicator will be given a mark under its different conditions, which is descripted as following.

4.2.1 Static Resource Indicators

•For range sufficiency, if all the area that needs FSC has been covered, the level is acceptable, scoring 1 point; if there are some omitted, the level is intermediate, scoring 0.5; if there is no coverage, the level is poor, scoring 0.

• For national legislation, if the national legislation is sufficient, the level is acceptable, scoring 1 point; if there are some omitted, the level is intermediate, scoring 0.5; if there is no national legislation, the level is poor, scoring 0.

• For quality system, if the quality system is sufficient and up-to-date, the level is acceptable, scoring 1 point; if there are some omitted or partially outdated, the level is intermediate, scoring 0.5; if there is no quality system or timely update, the level is poor, scoring 0.

• For working procedures, if the quality system is sufficient and up-to-date, the level is acceptable, scoring 1 point; if there are some omitted or partially outdated, the level is intermediate, scoring 0.5; if there is no quality system or timely update, the level is poor, scoring 0.

• For qualified personnel, if all the FSCOs are sufficient and well trained, the level is acceptable, scoring 1 point; if the number is insufficient or they have not been trained on schedule, the level is intermediate, scoring 0.5; if there is no FSCO or training, the level is poor, scoring 0.

• For data records/database, if the data is well recorded which can be checked at any moment, the level is acceptable, scoring 1 point; if there are some omitted or

partially outdated, the level is intermediate, scoring 0.5; if there is no records, the level is poor, scoring 0.

 • For overview, if they have the self-assessment done annually, the level is acceptable, scoring 1 point; if they are disjoint, the level is intermediate, scoring 0.5; if there is no such record, the level is poor, scoring 0.

Above all, the general criteria for the seven indicators can be expressed as shown in Figure 6.

Figure 6 Criteria of FSC Static Resource Performance

Source: Drawn by Author. (2018).

4.2.2 Dynamic Implementation Indicators

There are 14 MSA branches spreading in China and all the data used for calculation are obtained from the annual reports of PSC & FSC of P. R. China from 2015 to 2017. Table 8 summarizes how to calculate relative factors.

Table 8 Calculation Summary of FSC Dynamic Implementation Indicators (during the three-year rolling period)

FSC Station	S1	S2	S3	...	S14	Sum

Number of Inspections (m)	m1	m2	m3	...	m14	$M = \sum_{i=1}^{14} mi$
Number of Detentions (n)	n1	n2	n3	...	n14	$N = \sum_{i=1}^{14} ni$
Number of Deficiencies (p)	p1	p2	p3	...	p14	$P = \sum_{i=1}^{14} pi$
Number of Inspections with Deficiencies (q)	q1	q2	q3	...	q14	$Q = \sum_{i=1}^{14} qi$
Detention Rate ($\frac{n}{m}$)	$\frac{n1}{m1}$	$\frac{n2}{m2}$	$\frac{n3}{m3}$	...	$\frac{n14}{m14}$	$\frac{N}{M}$ *(For Regianal)*
Deficiency Rate ($\frac{p}{m}$)	$\frac{p1}{m1}$	$\frac{p2}{m2}$	$\frac{p3}{m3}$	...	$\frac{p14}{m14}$	$\frac{P}{M}$ *(For Regianal)*
Numbers of Deficiencies per Ship ($\frac{q}{m}$)	$\frac{q1}{m1}$	$\frac{q2}{m2}$	$\frac{q3}{m3}$	...	$\frac{q14}{m14}$	$\frac{Q}{M}$ *(For Regianal)*

Source: Drawn by Author. (2018).

•The detention rate per ship r1 equals the number of detained ships inspected by one FSC station over the number of total inspections happened in the FSC station during the three-year rolling period, which can be expressed as Equation 3a.

$$r1 = \frac{n}{m} * 100\% \tag{3a}$$

•The regional detention rate R1 equals the total number of detained ships in one region over the total number of inspections in the region during the three-year rolling period, which can be expressed as Equation 3d.

$$R1 = \frac{N}{M} * 100\% = \frac{\sum_{i=1}^{14} ni}{\sum_{i=1}^{14} mi} * 100\% \tag{3d}$$

• The deficiency rate per ship r2 equals the number of ships with deficiencies inspected by one FSC station by the total number of inspections happened in the FSC station during the three-year rolling period, which can be expressed as Equation 3b.

$$r2 = \frac{p}{m} * 100\% \qquad\qquad (3b)$$

- The regional deficiency rate R2 equals the total number of ships with deficiencies in one region over the total number of inspections in the region during the three-year rolling period, which can be expressed as Equation 3e.

$$R2 = \frac{P}{M} * 100\% = \frac{\sum_{i=1}^{14} pi}{\sum_{i=1}^{14} mi} * 100\% \qquad\qquad (3e)$$

- The number of deficiencies per ship t equals the total deficiencies found by one FSC station over the total number of inspections happened in the FSC station during the three-year rolling period, which can be expressed as Equation 3c.

$$t = \frac{q}{m} * 100\% \qquad\qquad (3c)$$

- The regional numbers of deficiencies in one inspection T is equal to the total deficiencies inspected in one region over the total number of inspections in the region during the three-year rolling period, which can be expressed as Equation 3f.

$$T = \frac{Q}{M} * 100\% = \frac{\sum_{i=1}^{14} qi}{\sum_{i=1}^{14} mi} * 100\% \qquad\qquad (3f)$$

As a result, to reflect directly the performance situation of the three indicators can be expressed as the following:

- The FSC detention situation SR1 equals the detention rate of one FSC station over the detention rate in the region during the three-year rolling period, which can be expressed as Equation 3g.

$$SR1 = \frac{r1}{R1} * 100\% \qquad\qquad (3g)$$

- The FSC deficiency situation SR2 equals the deficiency rate of one FSC station over the deficiency rate in the region during the three-year rolling period, which can be expressed as Equation 3h.

$$SR2 = \frac{r2}{R2} * 100\% \tag{3h}$$

• The FSC deficiency situation per ship ST equals the number of deficiencies in one inspection of one FSC station over that in the region during the three-year rolling period, which can be expressed as Equation 3i.

$$ST \quad = \frac{t}{T} * 100\% \tag{3i}$$

• To sum up, the FSC dynamic implementation indicators' performance PE is the sum total of the FSC detention situation SR1, the FSC deficiency situation SR2 and the FSC deficiency situation per ship ST, which can be expressed as Equation 3f.

$$PE = SR1 + SR2 + ST \tag{3j}$$

Here we can see that the equation 3a, 3b and 3c indicate the condition of detentions, deficiencies and deficiency number per ship in a FSC station; the equation 3d, 3e and 3f represent the three aspects' situation in one region; the equation 3g, 3h and 3i are the comparisons between the FSC station and the region.

Supposed that the value of the indicators of a FSC station is equal to that of the region, what comes out of the equation 3g, 3h and 3i, respectively, should be 1, a constant. That is to say, r1 = R1 = r2 = R2 = t = T = 1 and PE = 3, which is the benchmark of the dynamic implementation performance of a FSC station.

When the value of single FSC station is higher than that of the region, i.e. r1 > R1, r2 > R2 and t > T, it means that the FSCOs of this station work harder and have achieved a better performance. On the contrary, the performance of the FSCOs should be improved more or less. However, the performance which is waiting to be improved can be divided into two type: to be encouraged and to be warned, referring

to the WGB-list, which adds the grey list as an interval to evaluate flag States' performance. As mentioned above, the benchmark of the performance of a FSC station is 3. Therefore, all the calculating values more than or equal to 3 are in the grade of A, which means good performance. If the values are more than or equal to 1.5 but less than 3, they belong to the grade of B, meaning that FSCOs in these stations need work much harder to get their duties performed as the "A" style. Concerning the outcomes less than 1.5, the performance fells to the grade C, which means that those FSC stations should be warned, rectified and reformed. Figure 7 shows the classification in a directive way.
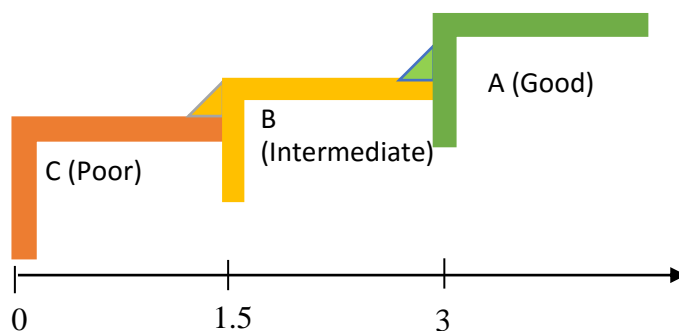
Figure 7 Criteria of FSC Dynamic Implementation Performance

Source: Drawn by Author. (2018).

4.2.3 Supervision Indicators

• For casualties, once there are casualties relating to FSC, no matter how many wounded or died, the score will be 0 point; the opposite will get 1 point, which means no related casualties.

•For effective complaint number, if at least one complaint is valid and related to FSC, the score will be 0 point; if there is no related complaint, the score will be 1.

Overall, the general criteria for the two indicators are shown in Figure 8.
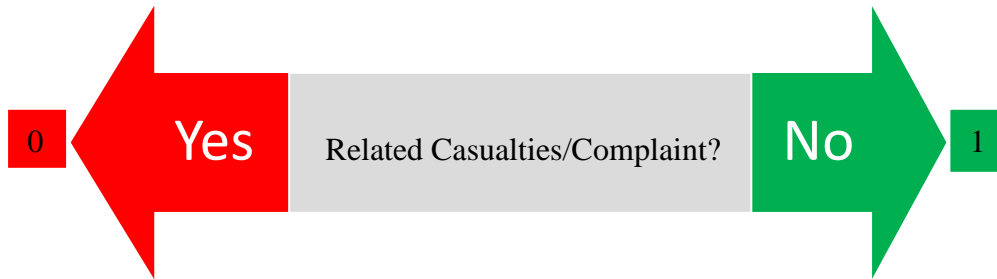
Figure 8 Criteria of FSC Supervision Performance

Source: Drawn by the Author. (2018).

4.3 The Performance Judgement of the RYG-list

Following the style of the WGB-list, the outcomes of the scoring system of the RYG-list in Table 7 can be divided into three levels as the FSC different performance. The criteria of the RYG-list to evaluate FSC performance are displayed in Figure 9.

According to the experts' advice, the FSC station achieving a total score of 15 and more belongs to the Green list, which indicates its performance is good, even excellent; the one with grades less than 15 but more than or equal to 7 is classified as the Yellow list, which means that it must devote more efforts to improving the performance. For those less than 7, the Red list is their only choice, which presents the serious inadequate work done for FSC duty implementation and special actions waiting to be taken to rectify the situation.

Figure 9 The Performance Judgement of RYG-list

Source: Drawn by the Author. (2018).

The experts consider that the three aspects supplement each other to make each other possible. If the effective complaint numbers are large and the casualties is high, the dynamic performance of the FSC station cannot get a high mark. Conversely, if a FSC station get a good mark, all the ten detailed indicators must be well performed. For those staying in the intermediate level, they should try their best to find the enhancing points and refine them to become members in the Green list. Besides, the evaluation period is the 36 months, which may not be three calendar years and can be changeable. That means that the list may be different in every evaluation period. Therefore, to be listed in the Green list does not means that there is nothing to worry about. All the members involved in the evaluation should keep on working hard and achieve the green level finally for better performance in FSC inspections.

4.4 Summary

This chapter has established the intact evaluation system by combining the experts' opinions with the assignment and quantitative scoring system. The detailed performance level can be judged by the different scores shown by the relative colors, which has been divided into three levels – Poor in red, Intermediate in yellow and Good in green. As a result, the performance can be identified easily and directly by the shown colors representing their real scores.

Chapter 5 Application and Verification of the RYG-List

Since the model RYG-list has been established in Chapter 4, everything seems ready. Due to the rigorous academic attitude, verifying its feasibility by applying relative data is needed. As the data from China are easy to obtain, the author take China FSC as an example and all the data are collected from China MSA during the period of 2015 to 2017.

5.1 Application

5.1.1 The Data of Static Resource Indicators

As China MSA has been set up for 20 years from 1998, it is a long-enough time to prepare all the pre-conditions ready for audit and assessment. Every year, there are at least two internal audits conducted by 14 branches and every three years, there must be one audit by the headquarter of China MSA.

From the reports of these audits from 2015 to 2017, the seven indicators involved in the static resource aspect in most branches can fulfil the requirements, but Fujian, Guangxi, Hainan and Heilongjiang. According to the reports, the quality system and the data in Guangxi are not updated on time, so 0.5 is for the two aspect respectively, and the same to those in Hainan; for Fujian, the data update is not on time, so 0.5 is achieved in the aspect; for Heilongjiang, the quality system is out of time and no data and overviews are done according to the requirements, so 0.5, 0 and 0 are the points for the three detailed indicators respectively. The others are all full marks. The scores of the 14 branches are as shown in Table 9.

Table 9 Results of Data Applied to Static Resource Indicators

MSA	RS	NL	QS	WP	QP	D	O	Score
Shanghai	1	1	1	1	1	1	1	7
Tianjin	1	1	1	1	1	1	1	7
Liaoning	1	1	1	1	1	1	1	7
Hebei	1	1	1	1	1	1	1	7
Shandong	1	1	1	1	1	1	1	7
Jiangsu	1	1	1	1	1	1	1	7
Zhejiang	1	1	1	1	1	1	1	7
Fujian	1	1	1	1	1	0.5	1	6.5
Guangdong	1	1	1	1	1	1	1	7
Guangxi	1	1	0.5	1	1	0.5	1	6
Hainan	1	1	0.5	1	1	0.5	1	6
Changjiang	1	1	1	1	1	1	1	7
Heilongjiang	1	1	0.5	1	1	0	0	4.5
Shenzhen	1	1	1	1	1	1	1	7

Source: Drawn by the Author. (2018).

5.1.2 The Data of Dynamic Implementation Indicators

All the data of 14 branches of China MSA from 2015 to 2017 are sorted out and displayed in Table 10. The relative results are displayed in Table 11 and 12.

Table 10 Inspection Data of 14 Branches from 2015 to 2017

MSA	Number of Inspections	Number of Detentions	Number of Deficiencies	Number of Inspections with Deficiencies
Shanghai	3251	134	20112	1676

Tianjin	1922	103	11791	983
Liaoning	4004	92	24217	2018
Hebei	3591	194	25901	2158
Shandong	6620	525	47866	3989
Jiangsu	7321	192	64478	5373
Zhejiang	14947	517	105657	8805
Fujian	9791	406	66270	5523
Guangdong	10258	502	72614	6051
Guangxi	1375	29	8494	708
Hainan	2809	148	17920	1493
Changjiang	1356	72	10706	892
Heilongjiang	0	0	0	0
Shenzhen	1355	134	9258	772
Total	68600	3048	485284	40440

Source: Drawn by the Author According to the Annual Reports of PSC & FSC of P. R. China for 2015, 2016 and 2017. (2018).

Table 11 Calculation Results of Detention Rate, Deficiency Rate and Number of Deficiencies per Ship

MSA	Detention Rate	Deficiency Rate	Number of Deficiencies per Ship
Shanghai	4.12%	51.55%	6.19
Tianjin	5.36%	51.12%	6.13
Liaoning	2.30%	50.40%	6.05

Hebei	5.40%	60.11%	7.21
Shandong	7.93%	60.25%	7.23
Jiangsu	2.62%	73.39%	8.81
Zhejiang	3.46%	58.91%	7.07
Fujian	4.15%	56.40%	6.77
Guangdong	4.89%	58.99%	7.08
Guangxi	2.11%	51.48%	6.18
Hainan	5.27%	53.16%	6.38
Changjiang	5.31%	65.79%	7.90
Heilongjiang	0.00%	0.00%	0.00
Shenzhen	9.89%	56.94%	6.83
Average	4.44%	58.95%	7.07

Source: Drawn by the Author. (2018).

Table 12 Results of Data Applied to the Dynamic Implementation Indicators

MSA	Detention Rate	Deficiency Rate	Numbers of Deficiencies per Ship	Mark
Shanghai	0.93	0.87	0.87	2.68
Tianjin	1.21	0.87	0.87	2.94
Liaoning	0.52	0.85	0.85	2.23
Hebei	1.22	1.02	1.02	3.26
Shandong	1.78	1.02	1.02	3.83
Jiangsu	0.59	1.24	1.24	3.08
Zhejiang	0.78	1.00	1.00	2.78

Fujian	0.93	0.96	0.96	2.85
Guangdong	1.10	1.00	1.00	3.10
Guangxi	0.47	0.87	0.87	2.22
Hainan	1.19	0.90	0.90	2.99
Changjiang	1.20	1.12	1.12	3.43
Heilongjiang	0.00	0.00	0.00	0.00
Shenzhen	2.23	0.97	0.97	4.16

Source: Drawn by the Author. (2018).

According to the criteria shown in Figure 7, the dynamic implementation indicators' level of 14 branches is classified and displayed in Table 13.

Table 13 The Performance Level of Dynamic Implementation Indicators

MSA	Mark	Level	Final Score
Shanghai	2.68	B	5
Tianjin	2.94	B	5
Liaoning	2.23	B	5
Hebei	3.26	A	10
Shandong	3.83	A	10
Jiangsu	3.08	A	10
Zhejiang	2.78	B	5
Fujian	2.85	B	5
Guangdong	3.10	A	10
Guangxi	2.22	B	5
Hainan	2.99	B	5

Changjiang	3.43	A	10
Heilongjiang	0.00	C	0
Shenzhen	4.16	A	10

Source: Drawn by the Author. (2018).

5.1.3 The Data of Supervision Indicators

Checking about the internal reports of accidents and anti-corruption, which will keep the records of the casualties and complaint number, for the three years, there is no fatal casualties related to the FSC inspections and also no complaints about FSC inspections. As a result, each of the branches can get the full mark, 2 points, which has been listed as Table 14.

Table 14 Results of Data Applied to the Supervision Indicators

MSA	Score
Shanghai	2
Tianjin	2
Liaoning	2
Hebei	2
Shandong	2
Jiangsu	2
Zhejiang	2
Fujian	2
Guangdong	2
Guangxi	2
Hainan	2
Changjiang	2
Heilongjiang	2
Shenzhen	2

5.1.4 The Synthesis of the Final Scores of 14 Branches

By combing all the data in Table 9, 13 and 14, the outcomes of 14 branches have been listed in Table 15.

Table 15 Final Scores of 14 Branches

MSA	Static Resource Indicators	Dynamic Implementation Indicators	Supervision Indicators	Final Score
Shanghai	7	5	2	14
Tianjin	7	5	2	14
Liaoning	7	5	2	14
Hebei	7	10	2	19
Shandong	7	10	2	19
Jiangsu	7	10	2	19
Zhejiang	7	5	2	14
Fujian	6.5	5	2	13.5
Guangdong	7	10	2	19
Guangxi	6	5	2	13
Hainan	6	5	2	13
Changjiang	7	10	2	14
Heilongjiang	4.5	0	2	6.5
Shenzhen	7	10	2	19

From the results in Table 15, the RYG-list for the 14 branches of China MSA can be classified as follows:

• Green List - Hebei MSA, Shandong MSA, Jiangsu MSA, Guangdong MSA and Shenzhen MSA.

• Yellow List - Shanghai MSA, Tianjin MSA, Liaoning MSA, Zhejiang MSA, Fujian MSA, Guangxi MSA, Hainan MSA and Changjiang MSA.

• Red List - Heilongjiang MSA.

5.2 Result Analysis and Suggestions

Generally, the performance of most of the branches of China MSA is above the intermediate level and can be improved furtherly. All the branches in Green have presented good performance in every aspect, especially in the dynamic implementation, which should be kept up and make persistent efforts. All the branches in Yellow list got the points between 13 and 14, very close to 15, which indicates the striving direction – improving their dynamic implementation performance by working harder on ship inspections and refine their quality system as well as data records. Heilongjiang is in Red list, the total score is 6.5. There are problems happening in out-of-date quality system, no data, no overviews and no inspections, so FSCOs in Heilongjiang MSA should work even harder on ship inspections, update their quality system, keep recording data and conduct post-evaluation every year to get out of the Red list.

According to the comments from the experts, the results can be the representative of the true FSC performance in China, which means that this method is valid and reasonable.

5.3 Summary

By applying FSC inspection data of China from 2015 to 2017 and combining with the experts' comments, 14 branches' performance has been shown clearly in the chapter. Their performance has also been analysed respectively according to different scores. Relative suggestions follow on. By acquiring the experts' opinion, the method is recognised feasible and rational, achieving the objective of this paper described in the beginning chapter.

Chapter 6 Conclusion

The paper mainly concentrates on establishing a method to evaluate FSC performance. In accordance with the status quo of FSC facing a lot of problems, for instance, the various degrees of rigour in inspections, the different levels of the FSCOs' professional competence, bribery, etc. The new-established method, the "Red, Yellow and Green List" (RYG-list) is a trial to refine the situation by assessing the actual performance of FSC.

After system engineering analysis, questionnaire and experts' opinion acquisition, three major categories have been extracted, which are static resource indicators, dynamic implementation indicators and supervision indicators. Under them, there are several factors supporting them as follows: the static resource indicators consist of range sufficiency, legislation, quality system, working procedures, qualified personnel, data records/database and overview, each of them weighting 1 point; the dynamic implementation indicators mainly focus on the detention rate, deficiency rate and number of deficiencies per ship in one FSC station and regional level, whose performance is classified into A (Good), B (Intermediate) and C (Poor), weighting 10 points, 5 points and 0 point respectively; the supervision indicators take the casualties and effective complaint number into account, each of which weighs 1 point. Then, the results of the calculation of the three indicators have been sorted out to determine which list the evaluated objective belongs to. When the total score is under 7, it is the red list, meaning poor performance; when the score is between 7 and 15, it is the yellow list, which means the performance can be improved in some

aspects; when the score is between 15 and 19, it is the red list, standing for the satisfied level of performance, which is the highlight of the paper.

Application and verification of the method are important. Data from the annual report of PSC & FSC of China from 2015 to 2017 have been used to verify its feasibility and rationality. By the results shown in the tables, the performance of each branches of China MSA is clear at a glance. After consulting the experts, the method is recognised feasible and rational.

Truly, no perfections can be sought in the world. There is much work waiting to be done on the road. In fact, the RYG-list is a rough model to assess the performance of FSC. In the future, all the weighting points of indicators can be discussed in a more detailed way to classify the performance level thoroughly. Also, it can refer to the actions taken in the USCG Qualship 21, connected with an incentive system to award the hard work of the green list, encourage the yellow list and punish the red list, which will be more meaningful and highly stimulating when used and can be the aspect for further study.

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Appendix 1

White, Grey and Black List in 2016 released by Paris MOU

White list

RANK	FLAG	INSPECTIONS 2014-2016	DETENTIONS 2014-2016	BLACK TO GREY LIMIT	GREY TO WHITE LIMIT	EXCESS FACTOR
WHITE LIST						
1	Cayman Islands, UK	393	1	36	19	-1.91
2	France	266	0	26	11	-1.91
3	Denmark	1,201	9	99	69	-1.90
4	Netherlands	3,103	35	241	193	-1.84
5	Bahamas	2,291	27	181	140	-1.80
6	Italy	1,164	13	96	67	-1.75
7	Hong Kong, China	1,921	25	153	116	-1.73
8	Marshall Islands	3,704	54	285	233	-1.73
9	United Kingdom	1,260	15	104	73	-1.73
10	Norway	1,450	18	118	85	-1.73
11	Isle of Man, UK	747	8	64	40	-1.70
12	Sweden	331	2	31	15	-1.69
13	Singapore	1,816	26	146	109	-1.68
14	Belgium	219	1	22	9	-1.59
15	Germany	629	8	55	33	-1.58
16	Ireland	124	0	14	4	-1.45
17	Greece	917	18	77	51	-1.37
18	Finland	407	6	37	20	-1.36
19	Cyprus	1,965	47	157	118	-1.32
20	Luxembourg	213	2	22	8	-1.32
21	Bermuda, UK	241	3	24	10	-1.24
22	Gibraltar, UK	770	17	66	42	-1.23
23	Malta	4,586	135	350	292	-1.21
24	Liberia	4,170	128	320	264	-1.15
25	China	207	3	21	8	-1.04
26	Latvia	85	0	10	2	-0.96
27	Philippines	151	2	16	5	-0.87
28	Estonia	79	0	10	1	-0.86
29	Barbados	325	8	31	15	-0.84
30	Portugal	582	18	51	30	-0.80
31	Faroe Islands, DK	256	6	25	11	-0.77
32	Antigua and Barbuda	3,160	129	245	197	-0.76
33	Saudi Arabia	73	0	9	1	-0.75
34	Kazakhstan	72	0	9	1	-0.73
35	Japan	94	1	11	2	-0.54
36	United States of America	194	5	20	7	-0.50
37	Panama	6,082	313	459	393	-0.45
38	Iran, Islamic Republic of	89	1	11	2	-0.44
39	Russian Federation	1,258	61	103	73	-0.34
40	Croatia	108	2	12	3	-0.31
41	Spain	173	5	18	6	-0.28
42	Turkey	1,237	65	102	71	-0.19

Grey list

RANK	FLAG	INSPECTIONS 2014-2016	DETENTIONS 2014-2016	BLACK TO GREY LIMIT	GREY TO WHITE LIMIT	EXCESS FACTOR
GREY LIST						
43	Korea, Republic of	90	2	11	2	0.02
44	Poland	123	4	14	3	0.05
45	Kuwait	36	0	6	0	0.08
46	Lithuania	137	6	15	4	0.17
47	Switzerland	126	6	14	4	0.23
48	Libya	33	1	5	0	0.27
49	Morocco	43	2	6	0	0.34
50	Algeria	74	4	9	1	0.36
51	Thailand	72	4	9	1	0.37
52	India	71	4	9	1	0.38
53	Azerbaijan	31	2	5	0	0.47
54	Egypt	52	4	7	0	0.55
55	Bulgaria	38	3	6	0	0.56
56	Curacao	149	12	16	5	0.64
57	Albania	68	6	9	1	0.66
58	Saint Vincent and the Grenadines	647	50	56	34	0.71
59	Tunisia	41	5	6	0	0.83
60	Lebanon	74	8	9	1	0.84
61	Ukraine	129	14	14	4	0.97

Black list

RANK	FLAG	INSPECTIONS 2014-2016	DETENTIONS 2014-2016	BLACK TO GREY LIMIT	GREY TO WHITE LIMIT	EXCESS FACTOR	RISK
BLACK LIST							
62	Belize	488	47	44	24	1.19	Medium Risk
63	Cook Islands	404	40	37	19	1.20	
64	Vanuatu	277	31	27	12	1.43	
65	Saint Kitts and Nevis	299	34	29	13	1.52	
66	Cambodia	293	36	28	13	1.78	
67	Sierra Leone	260	39	25	11	2.52	Medium to High Risk
68	Palau	123	23	14	3	3.09	High Risk
69	Comoros	228	40	23	9	3.20	
70	Moldova, Republic of	515	85	46	26	3.30	
71	Togo	399	70	37	19	3.51	
72	Tanzania United Rep.	211	40	21	8	3.57	
73	Congo, Republic of the	86	24	10	2	5.40	Very High Risk

Appendix 2

Performance Indicators (PIs)

SD	PI Index	PI Name
SD 1 Improve implementation	PI 1.1	# of references in audit findings per instrument (article and regulation)
	PI 1.2	% of audit findings and observations with corrective actions implemented according to the target completion dates
	PI 1.3	% of deficiencies and detentions per ship type
	PI 1.4	# of deficiencies per category of deficiency
	PI 1.5	# of Member States that have ratified each IMO instrument, including those yet to enter into force
	PI 1.6	% of the world's merchant shipping (tonnage) covered by each IMO instrument, including those yet to enter into force
	PI 1.7	# of Member States requesting technical cooperation to implement corrective actions to address audit findings and observations
	PI 1.8	# of Member States receiving technical cooperation to implement corrective actions to address audit findings and observations
	PI 1.9	% of technical cooperation activities directed towards the implementation of IMO instruments with effective results for the receiving Member States
SD 2 Integrate new and advancing technologies in the regulatory framework	PI 2.1	# of proposals submitted to IMO to incorporate new and advancing technologies into the regulatory framework
	PI 2.2	# of outputs to include new and advancing technologies (as specified in PI 2.1) on the agenda of IMO organs
	PI 2.3	# of amendments adopted to incorporate new and advancing technologies into the regulatory framework
SD 3 Respond to climate change	PI 3.1	# tonnes of CO_2 emissions from international shipping
	PI 3.2	% of improvement in attained EEDI against reference line per ship type
	PI 3.3	US$ expenditure on funding of technical cooperation activities and major projects related to energy efficiency and reduced emissions
SD 4 Engage in ocean governance	PI 4.1	# of Special Areas designated under MARPOL, including ECAs
	PI 4.2	# of Particularly Sensitive Sea Areas (PSSAs) designated
	PI 4.3	# of meetings on Ocean Governance at which the Organization was represented
	PI 4.4	US$ expenditure on technical cooperation activities and capacity building related to Ocean Governance

SD 5 Enhance global facilitation and security of international trade	PI 5.1	# of Contracting Parties to the FAL Convention submitting notifications pursuant to article VIII of the FAL Convention
	PI 5.2	# of Member States issuing electronic certificates
	PI 5.3	# of Member States with a system for the electronic exchange of information
	PI 5.4	# of piracy incidents per geographical area of incident reported to IMO
	PI 5.5	# of stowaway incidents reported to IMO
	PI 5.6	US$ expenditure on technical cooperation activities and capacity building allocated to facilitation matters
	PI 5.7	US$ expenditure on technical cooperation activities and capacity building allocated to security matters
SD 6 Ensure regulatory effectiveness	PI 6.1	# of specific requirements of the relevant IMO instruments recommended for review based on audit findings
	PI 6.2	# of unified interpretations of provisions per instrument approved by IMO
	PI 6.3	# of amendments per mandatory instrument within four years of entry into force
SD 7 Ensure organizational effectiveness	PI 7.1	# and % of Member States, IGOs and NGOs attending IMO meetings by meeting
	PI 7.2	% of outputs completed by the original target completion date
	PI 7.3	% of technical cooperation and capacity-building activities with effective results for the receiving Member States
	PI 7.4	% of technical cooperation and capacity-building activities with long-term impact for the receiving Member States
	PI 7.5	% of the reporting requirements that can be met by electronic means
	PI 7.6	% of vacant posts in general and professional/higher categories
	PI 7.7	% of assessments received from Member States
	PI 7.8	% of biennial ITCP funded
	PI 7.9	% contribution of Trading Fund surplus to the ITCP
	PI 7.10	% of additional external contributions to the budget (non-ITCP)
	PI 7.11	% of contributions provided by substantial donations

Appendix 3

<p align="center">Questionnaire for Experts' Opinions</p>

Part One:

Expert's Name		
Category	**Detailed Indicators**	**Point**
Static Resource Indicator	Range Sufficiency	
	National Legislation	
	Quality System	
	Working Procedures	
	Qualified Personnel	
	Data Records/Database	
	Overview	
Dynamic Implementation Indicator	A (Good)	
	B (Intermediate)	
	C (Poor)	
Supervision Indicator	Casualties	
	Effective Complaint Number	
Full Mark		19

Part Two:

Performance	Point Range
Red List (Poor Performance)	
Yellow List (Intermediate Performance)	
Green List (Good Performance)	
Full Mark	19