

## Marine Traffic Safety Diagnostic Scheme in Korea

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**Abstract:** According to the Marine Traffic Safety Law, revised in 2009, Marine Traffic Safety Diagnostic Scheme is introduced to secure the safe navigation, prevent the marine accident and to maximize the efficiency of the port operation. The diagnostic system aims to investigate, measure and evaluate the effect of the various development project such as the construction of bridge over navigable waterway, and of piers in port and etc. Then the diagnostic results should be reflected on the project designed for the safe navigation. This paper introduces the Marine Traffic Safety Diagnostic Scheme includes the diagnostic process, evaluation items, diagnostic criteria, registration criteria of the diagnostic agent and the standards of written diagnostic report. This paper also discusses various marine traffic safety evaluation model including ES model & IWRAP model which is the most important part of the system.

**Keywords:** marine traffic safety diagnostic, safe navigation, diagnostic process, diagnostic criteria, diagnostic agent, diagnostic report, marine traffic safety evaluation model.

## 1. INTRODUCTION

The probability of navigational accident is increasing significantly with growth of ship's size, variety of marine facilities, bridges crossing waterways and port development in Korean coastal waters. Especially, the construction of bridges crossing navigable waterway

is being promoted aiming at expanding social infrastructure and optimizing the overland routes through private investment. The construction, however, tends to focus more on the commercial requirements rather than on the marine traffic safety, which causes big risks not only threatening the safety of ship traffic, but also causing some severe conflicts among the stakeholders.[1]

For this reason, the Ministry of Land, Transport and Maritime Affairs(MLTM) amended the Korean Marine Traffic Laws to enact the Marine Traffic Safety Diagnostic Scheme (MTSDS) which is to evaluate the traffic safety for all kinds of port and water facilities concerning with ship's passage. The act took effect from Nov. 2009.[2]

The purpose of this paper is to introduce the diagnostic scheme which includes the process, evaluation items, diagnostic criteria, registration criteria of the diagnostic agent and the standards of written diagnostic report and a discussion of various marine traffic safety evaluation models.

## **2. MARINE TRAFFIC SAFETY DIAGNOSTIC SCHEME**

The Marine Traffic Safety Diagnostic Scheme (MTSDS) is briefly introduced in this part.[3]

### ***2.1 Concept of MTSDS***

MTSDS is a formal safety diagnosis examination in the field of existing or future maritime transportation by an independent audit team. It systematically estimates and identifies the potential risk elements associated with the development plan and provide an opportunity to improve the traffic safety for developers. Therefore, MTSDS is to identify potential safety hazards which may affect all mariners from the initial design phase, and to suggest all possible measures to eliminate or mitigate those problems.[4]

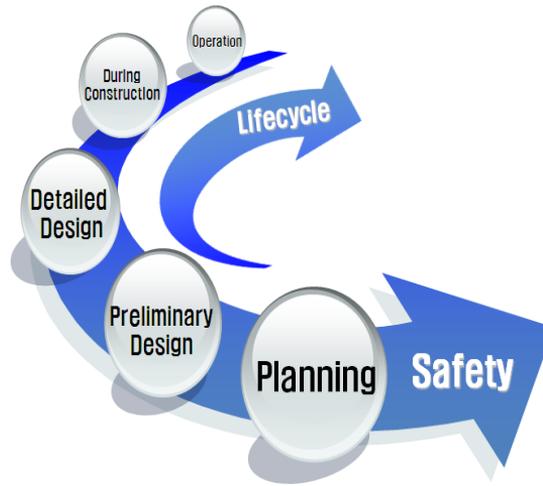
The Article 2 (Definition) in the Korean Marine Traffic Safety Law defines the audit scheme as the professional investigation, measurement and evaluation of the safety hazards that may occur from the projects listed below;

- 1) The establishment and change of water zones
- 2) The construction, laying and repairing of bridges, tunnels and/or undersea cables in the water zones
- 3) The development and redevelopment of harbors and ports
- 4) Projects regulated by the ordinances of the Ministry(MLTM) as a project that remarkably affects other maritime traffic safety.

MTSDS is now a mandatory requirement in all marine projects except in special circumstance like emergency construction which makes little influence on navigational safety. In this case, it is possible to submit in a simplified audit report which can exclude full-mission ship handling simulation.

### ***2.2 Efficiency of audit scheme***

In general, it is known that faster the audit is performed, safer the results are obtained and the less costs are incurred. That is, it is more advantageous to make a compensation through a feasibility study or an audit in the initial design phase than during construction stage.[6]



Construction processing analysis of domestic bridges crossing navigable waterways and improvements, 2010

**Figure 1.** Relation between project lifecycle and safety improvement

In addition, the potential benefits obtained through the implementation of an audit system are listed below;

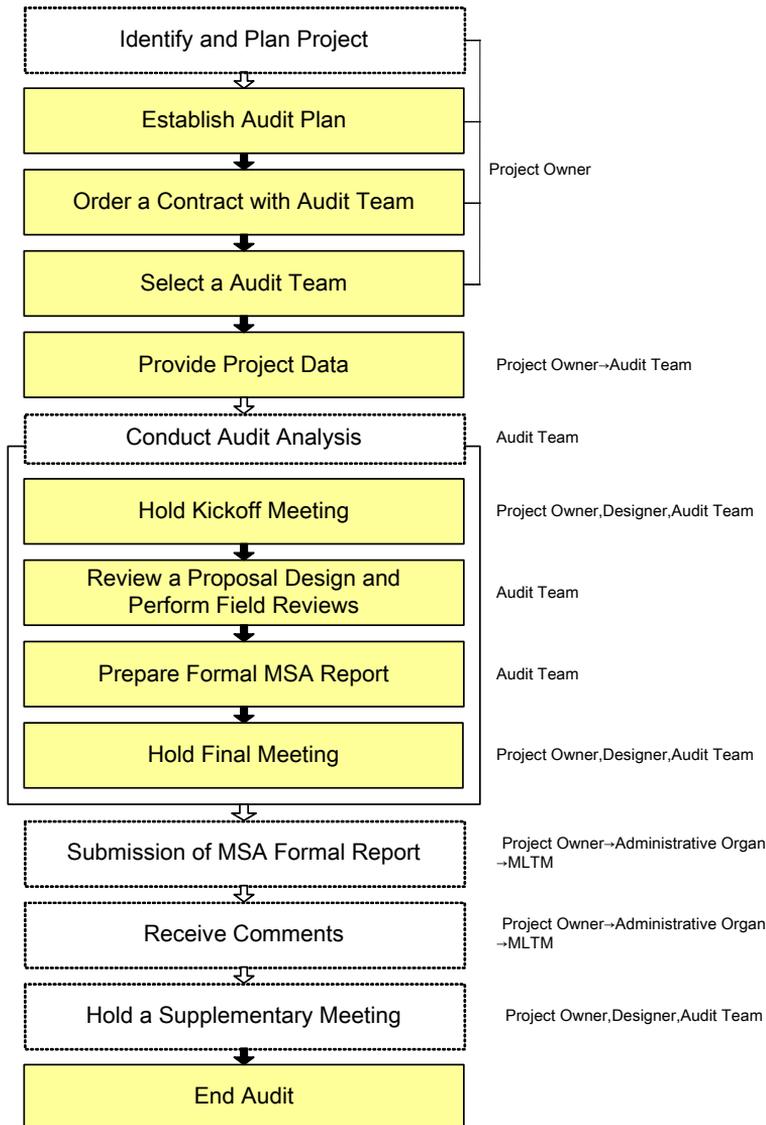
- 1) The possibility of occurrence of marine casualties can be reduced and the consequent savings in marine accident-related costs can be made;
- 2) The efficiency in a harbor operation is maximized through the safer traffic and smoother operation;
- 3) The Waterway becomes safer
- 4) Designers come to pay attention to the safety of vessels
- 5) The possibility of additionally implemented safety measures can be reduced, and the overall risk is reduced
- 6) The design technology considering the structures in maritime field is improved
- 7) Economic benefits are expected by blocking the factors that may cause marine incidents

It is expected to have an advantage in improving safety policies and project designs in an economic aspect of reducing marine incidents when the audit system is executed.

Badly designed and maintained sea routes can contribute to human error and lead to marine incidents. Conversely, well designed and maintained sea routes, where the needs of mariners have been anticipated, can reduce potential risks.

### **2.3 Process of MTSDS**

The audit typically proceeds according to the process as shown in Figure 2. Even though some steps can be omitted or simplified according to the characteristics and scale of the project, but basically, the steps for performing an audit should be observed. Also another important thing is to listen the opinions of marine user groups during the kick-off & final meeting in a process of auditing.



Construction processing analysis of domestic bridges crossing navigable waterways and improvements, 2010

**Figure 2.** Process of MTSDS

### 2.4 Investigation items

The essential items during the audit are needed for the procedures of performing the evaluation, using all kinds of evaluation technologies like a simulation technology, and establishing the safety measures required on a basis of the evaluation results after the basic investigation on maritime traffic and the traffic states are measured.

Table 1 show an investigation and evaluation methods that have to be performed in detail. The vertical axis shows the projects of audit objects and the horizontal axis lists

the method of the investigation and a standard method of the audit, which all should be performed for each object project, and whether or not to hold an evaluation committee. The mark “●” in the table means the item must be evaluated, but the mark “△” means the item may be reviewed as necessary.

**Table 1.** Performance audit items by projects

Schemes		Survey of traffic state	Measurement of traffic state	Adequacy Assessment				Safety Measures
				Navigational Safety	Berth/ Un-berth	Mooring	Traffic Flow	
Water zone	Establishment	●	●	●	△	-	△	●
	Change	●	●	●	△	-	-	●
Facility	Construction	●	●	●	△	△	●	●
	Repair	●	●	●	-	-	-	●
Harbor/ piers	Development	●	●	●	●	●	△	●
	Redevelopment	●	●	●	●	●	-	●
Other Project		●	●	●	△	△	△	●

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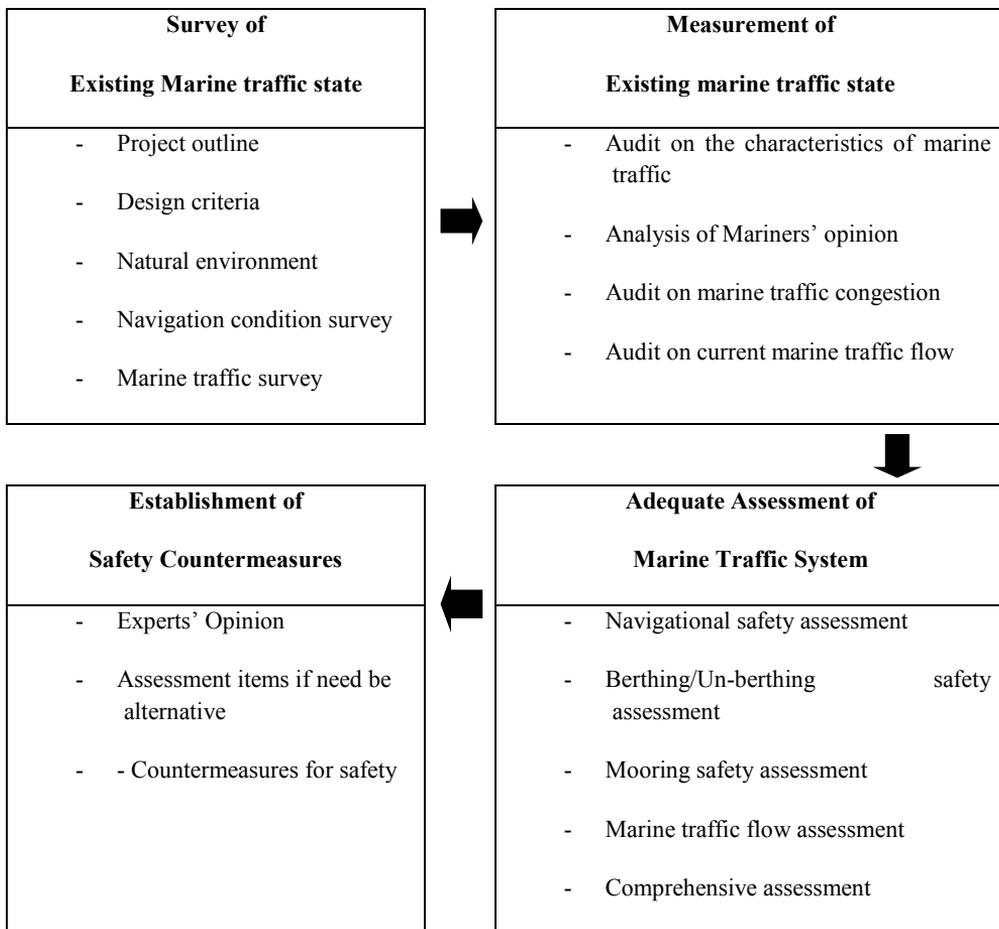
### 2.5 Assessment committee

An audit assessment committee, composed of over 20 persons, shall be established to evaluate the audit report professionally, and the results of the committee shall be reported to the Ministry (MLTM). The assessment results made by the Committee shall be notified to the project owner with any review opinion, and in case it is judged to be a poor audit, suspension shall be imposed.

Since it is difficult to form an assessment committee for every audit object due to a time and budget limit, thus the evaluation on audit results shall be performed under one of the following conditions.

- 1) In case a safety audit is not properly performed and it may result in a serious risk to maritime traffic safety
- 2) In case a project for audit objects seriously affects maritime traffic safety
- 3) The Ministry (MLTM) and the administrative organization acknowledge the fact that, judge from the results, a poor audit has been performed and require an audit team to evaluate those results.

Table 2. Audit items



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**2.6 Audit institute**

The objective of selecting an audit institute is to choose an independent, qualified and multidisciplinary team of experts who can successfully conduct the safety audit. It may be fair to say that success of failure of the MTSDS depends on the quality and ability of the selected audit institute. The role of audit institute is very important in MTSDS.

An audit institute is recommended to consist of a minimum of 8 experts and required to be independent from the design team. Also they should be registered to the MLTM and equipped with the facility of three dimensional full mission ship handling simulator.

There are three registered audit institutes such as Mokpo Maritime University(MMU), Maritime & Ocean Engineering Research Institute(MOERI) and Korea Maritime University(KMU), and one more will be registered shortly (Korea Institute of Maritime & Fisheries Technology, KIMFT) at the moment.

### 2.7 Prepare the audit report

The audit report prepared by the audit institute is expected to describe potential safety problems and identify the recommendations to overcome or mitigate them.

The main body of the audit report will contain all of the identified safety issues, evaluation of safety risks and suggestions concluding statement signed by the audit team members indicating that they have participated in the audit and agreed consensus on its findings. Especially, all safety problems highlighted should be stated as clearly as possible.

The suggestions and recommendations on audit reports should be constructive and realistic considering the costs, and should recognize that project owners may have different options to achieve the desired result.

## 3. MARINE TRAFFIC SAFETY ASSESSMENT MODEL

The most important part of the MTSDS will be the process of risk assessment in the areas concerned. This chapter introduces various risk assessment models including ES model and IWRAP model used widely.

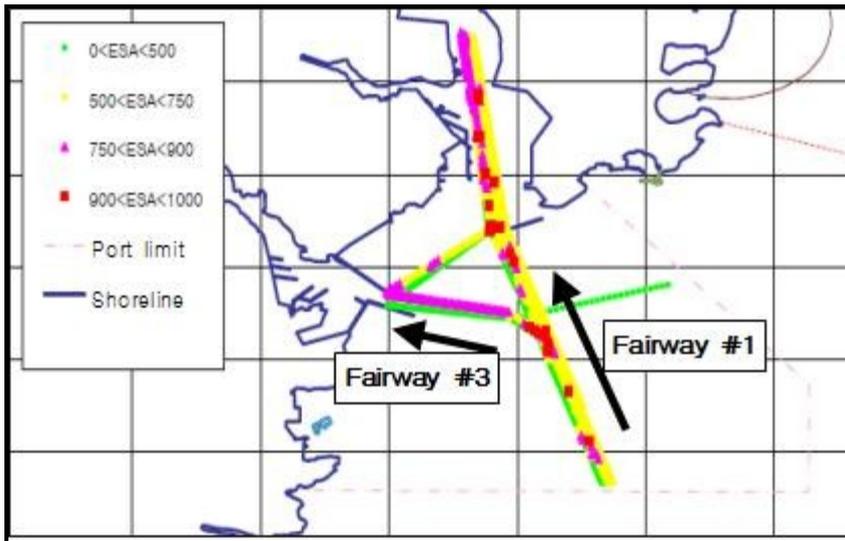
### 3.1 Environmental Stress (ES) Model

ES model is the most frequently used risk assessment model in the MTSDS. This model clarifies the acceptance criteria of the stress value based on mariners' perception of safety. Also this model evaluate the difficulty of ship handling arising from restrictions in maneuvering water area and arising from traffic congestion.[8]

ES model is composed of the following three parts.[9]

- 1) Evaluation of ship handling difficulty arising from restrictions on the water area available for maneuvering. A quantitative index expressing the degree of stress forced on the mariner by topographical restrictions ( $ES_L$  value – environmental value for land) is calculated on the basis of the time to collision (TTC) with any obstacles.
- 2) Evaluation of ship handling difficulty arising from restrictions on the freedom to make collision avoidance maneuvers. A quantitative index expressing the degree of stress forced on the mariner by traffic congestion ( $ES_S$  value – environmental stress value for ship) is calculated on the basis of the time to collision (TTC) with ships.
- 3) Aggregate evaluation of ship handling difficulty forced by both topographical and traffic environments, in which the stress value ( $ES_A$  value – environmental stress value for aggregation) is derived by superimposing the value  $ES_L$  and the value  $ES_S$ .

In the respective calculations of the values  $ES_L$  and  $ES_S$  a common index was used and the same algorithm was introduced to perform simultaneous aggregate evaluations of ship handling difficulty as experienced in encounters with other ships in ports and narrow waterways.



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**Figure 3.** Result of ES model assessment, Ulsan, Korea

When  $ES_A$  value is over 750, it is classified as unacceptable criteria of stress for mariners. Figure 3 is the assessment result of Ulsan, Korea. It is found that environmental stress of No.1 and NO.3 fairway is partially unacceptable. [10]

However, there are some problems that ES model would not correct because it reflected the Japanese mariners' sense of risk and applying risk of inside and outside of fairway is same.

### 3.2 IALA Waterway Risk Assessment Program (IWRAP)

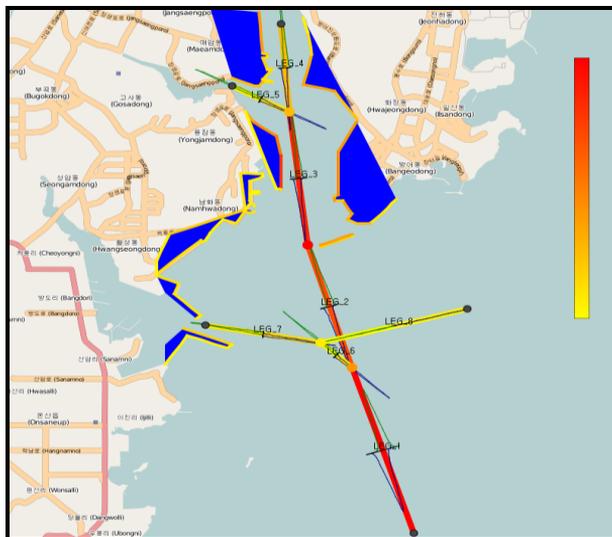
IWRAP is one of the representative quantitative assessment model. The objective of this model is quantifying the risks involved with vessel traffic in specific geographical areas. On the basis of a specified traffic condition and other elements, IWRAP calculates the annual number of collision and grounding in the specified navigational area.[11]

IWRAP is composed with Model view which inputs a basic vessel traffic data and Job view which show a result of probability data and risk analysis chart. In Model view, basic data is input to calculate probabilities such as route setting, traffic volume, causation factor, depth, weather condition, etc. Job view can check the result values and show risk visualized charts.

**Table 3.** Result of IWRAP assessment, Ulsan, Korea

Case	Result	Unit
Powered Grounding	1.37536	Incidents / Year
Drifting Grounding	0.839026	Incidents / Year
<b>Total Groundings</b>	<b>2.21438</b>	<b>Incidents / Year</b>
Overtaking	0.198466	Incidents / Year
Head On	0.263021	Incidents / Year
Crossing	0.0440573	Incidents / Year
Merging	0.0287787	Incidents / Year
Bend	0.147784	Incidents / Year
Area	2.70438*e <sup>-07</sup>	Incidents / Year
<b>Total Collisions</b>	<b>0.682107</b>	<b>Incidents / Year</b>

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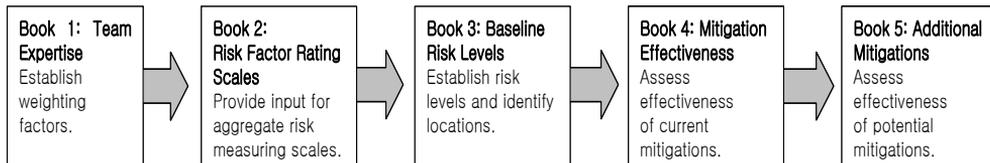
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**Figure 4.** Visualized result of IWRAP assessment, Ulsan, Korea

Table 3 and Figure 4 shows the result of IWRAP assessment by same data with ES model assessment. As seen above, high risk points are similar to ES model results.

### 3.3 Other Models

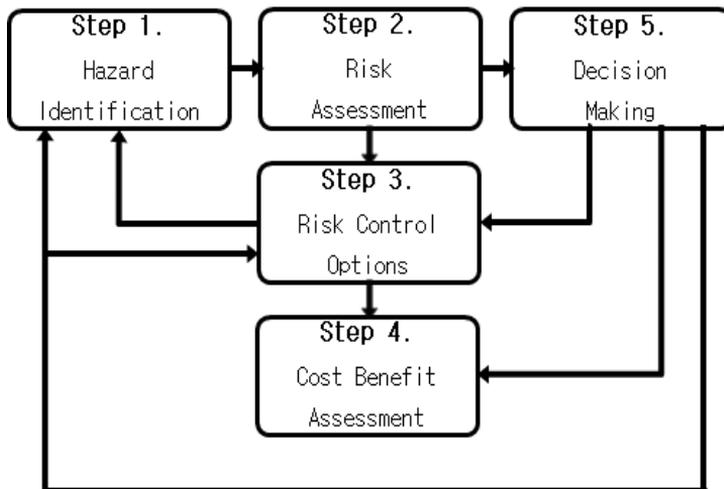
Another assessment tool recommended by the IALA is PAWSA, Ports And Waterway Safety Assessment, which is developed by United States Coast Guard. 5 steps of PAWSA is illustrated in Figure 5.



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Figure 5. Process of PAWSA

Formal Safety Assessment (FSA) tool is widely used in maritime sector, since it is adopted by the Maritime Safety Committee of IMO in 2001. FSA has also 5 steps of process which is shown in Figure 6.



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Figure 6. Process of FSA

Other tools are MARA (Marine Traffic Risk Assessment) which is developed by the Hong Kong, and PMSC (Port Marine Safety Code) which is developed by U.K. based on the FSA methodology.

## 4. CONCLUSIONS

The possibility of navigational accident is increasing significantly with growth of ship's size & volume, variety of marine facilities, bridges crossing waterways and port development in Korean coastal waters. Especially, the construction of bridges crossing navigable waterway brought severe conflicts among the stakeholders.

In this regards, the Ministry (MLTM) introduced MTSDS to enhance the marine traffic safety, and to reduce the marine accidents ultimately.

This paper introduced the MTSDS including the concept of MTSDS, necessity/efficiency/ process of the audit, investigation items, experts committee to evaluate the audit report and audit institute.

Although the MTSD Scheme, that has just begun, has some imperfection and some parts should be revised, we are sure the scheme significantly contribute to enhance the marine traffic safety in the Waterway, and to give clear guidelines to the designers (port construction & civil engineering) who involve in the project planned.

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