

## A Review of the Development of Safety Culture in Shipping Enterprises

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### Abstract

**In recent years, the safety culture, as a hot issue, has attracted wide attention from different industries and obtained fruitful result findings. Despite the high-risk nature of the shipping industry, it hasn't paid sufficient attention to the study of safety culture. In China, the research on safety culture of shipping enterprises has just started and is in need of in-depth investigation. Based on the study of safety culture in other industries, this paper analyzes the main directions, theoretical methods and contents of safety culture construction in the shipping industry, in hope of providing a new research direction for the safety of shipping.**

### Keywords

**Safety culture, shipping enterprises, Safety culture measurement.**

### 1. Introduction

On April 26, 1986, a big safety accident occurred in Chernobyl nuclear power plant, affecting two billion people worldwide. An investigation by the International Atomic Energy Agency (IAEA) and the Organization for Economic Co-operation and Development (OECD) concluded that a "weak safety culture" was the major factor of accident. In 1912, the Titanic (RMS Titanic) collided with an iceberg during its maiden voyage, resulting in a fatal accident of 1517 people. At the end of the following year, during the first International Conference on the Safety of Life at Sea held in London, the first International Convention on Safety of Life at Sea (SOLAS) was signed (1914) as a precedent for guidance documents.

The shipping industry has always been known for its high risks. With the progress of society and the rapid development of science and technology, ships are moving toward large-scale, specialization, high-speed and intelligent development. The probability of potential maritime risks has not decreased but increased, and major accidents have occurred from time to time.

In 1986, the concept of safety culture was first proposed in the analysis of the accident report of the Chernobyl nuclear power plant in the former Soviet Union. In China, the study of safety culture started relatively late. The nuclear power companies, coal companies and other high-risk industries have successively carried out relevant safety culture research, however, the investigation of safety culture in shipping industry is relatively in its infancy with only a few studies.

### 2. Definition of the Safety Culture of Shipping Companies

The concept of "safety culture" originated in the United States in the 1980s. In China, "Culture" is usually translated as "文化", which also means "nurture, cultivation, refinement, education". Generally, the academic community believes that safety culture stems from the safety atmosphere. In 1986, the International Nuclear Safety Advisory Group first proposed the concept of safety culture after the explosion at the Chernobyl nuclear power plant. Since then,

safety culture has received extensive attention and research from domestic and foreign experts or institutions.

### **2.1. Definition of Safety Culture by Foreign Scholars**

Numerous definitions of safety culture abound in the literature of safety culture. The International Nuclear Safety Advisory Group gave the definition of safety culture for the first time in the final report named "Safety Culture" (INSAG-4) in 1991 after the explosion accident of Chely Nuclear Power Station, that is, safety culture is the sum of all qualities and attitudes existing in institutions and individuals. It establishes a concept of importance beyond everything, that is, the safety of nuclear power plants should be given due attention because of its importance.

The International Atomic Energy Authority (IAEA, 1991) defined safety culture as, "the assembly of characteristics and attitudes in organisations and individuals which establishes that, as an overriding priority, nuclear plant safety issues receive the attention warranted by their significance".

The Confederation of British Industry (CBI, 1991) defined safety culture as, "the ideas and beliefs that all members of the organisation share about risk, accidents and ill health". The British Health and Safety Commission's Nuclear Facilities Safety Advisory Committee (HSCASNI) revised the definition of INSAG, believing that the safety culture of a unit is a comprehensive product of individual and collective values, attitudes, abilities and behaviors. Commitment, work style and proficiency.

Apart from the aforementioned institutions, some scholars have also provided definitions of safety culture. For instance, Zohar (1980) defined safety culture as a summary of molar perceptions that employees share about their work environments, Cox (1991) defines safety culture as employees' attitudes, beliefs, perceptions, knowledge and values that employees share in relation to safety. Hale (2000) defined safety culture as the common attitudes, beliefs and understandings of the organization; the safety culture defines the norms and values, which determines how the organization acts and feedbacks in the relevant aspects of risk and risk control system. Cooper (1998) defined safety culture as the degree of effort that all members of the organization can identify in terms of attention and actions to improve daily safety; it affects the attitudes and behaviors of employees and organizations related to health and safety performance. Richter and Koch (2004) defined safety culture as the common meaning, experience, and explanations gained in work and safety. It guides people's actions in terms of risks, accidents, and prevention. Fang (2006) and others define safety culture as a set of dominant instructions, beliefs and values held by safety-related organizations. Clarke (1999) defined safety culture as a subset of organizational culture, beliefs and values related to health and safety.

### **2.2. Definition of Safety Culture by Chinese Scholars**

In China, the study of safety culture is generally based on internationally accepted explanations. Xu (2004) believes that safety culture is the sum total of safe material wealth and safe spiritual wealth in all fields of production in human survival, reproduction and development. Luo (2002) believes that safety culture is the sum of the safety production, safe life spirit, ideas, behavior and physical state created by human safety activities. Fu (2013) believes that safety culture is the guiding principles of safety management required by enterprises. The State Administration of Work Safety of China defined safety culture in the "Guidelines for the Construction of Enterprise Safety Documents AQ / T9004-2008" and "Evaluation Criteria for the Construction of Enterprise Safety Culture AQ / T9005-2008" as the safety values, attitude, morality and code of conduct shared by the employee groups of enterprises.

### 2.3. Definition of the Safety Culture By Shipping Companies

It is generally believed that the proposal of the “Steamboat Navigation Rules” was the initial stage of the budding of safety culture of the shipping industry. In October 1840, the proposal of the International Convention for the Safety of Life at Sea 1974 (SOLAS74) considered that the shipping industry formally attached importance to safety culture. Wang Qi (2006) believes that the shipping safety culture refers to the spirit, ideas, behaviors and physical state of safe production, safe life and environmental protection created by all relevant industries in the shipping industry in shipping production activities. It embodies the integration of standards. Ye Yueqian (2003) believes that the definition of shipping safety culture can help to determine the individual, group values, attitudes, cognitions, abilities and behavior patterns of commitment, style, proficiency and organizational safety management.

Based on previous research, the safety culture of shipping can be reconstructed and defined from four elements according to the safety definition method, shipping culture perspective, shipping safety perspective and final purpose (refer to the analysis of factors, optimization and setting results, see Figure 1).



**Fig 1.** Conceptual model of safety culture

In summary, a series of scholars or organizations such as the International Nuclear Safety Advisory Group, the British Health and Safety Commission Nuclear Facilities Advisory Committee, the World Health Organization, and the former affiliated institutions of the Ministry of Labor of China, such as the China Labor Protection Science Association, have offered definitions or conceptions of safety culture on the basis of their own understandings. Comparatively speaking, there is less research on the definition of safety culture in shipping industry, and further study of its nature and connotation is needed.

## 3. The Main Research Content of the Safety Culture of Shipping Enterprises

### 3.1. Concept Definition

As mentioned previously, the nuclear industry, coal mining industry, construction industry, air transportation industry and other high-risk industries have conducted a lot of research on safety culture, but the definition of the safety culture of shipping enterprises has not been thoroughly studied, and it remains to be a hot issue for relevant experts and scholars one.

### 3.2. Constituent Element

Zohar (1980) believes that the main elements of the safety culture are the importance of safety training, the attitude of safety management, the impact of safety behavior on promotion, the degree of danger in the workplace, the degree of safety in the workplace, the status of safety personnel, and the influence of safety behavior on social status, status of security committee.

Hayes et al. (1991) believed that the elements of safety culture consisted of work safety, work partner safety, supervisor safety, management safety and safety program satisfaction. In 2008, the State Administration of Work Safety promulgated the "Guidelines for Enterprise Safety Culture Construction AQ / T9004-2008" and "Guidelines for the Evaluation of Enterprise Safety Culture Construction AQ / T9005-2008" to guide safe production. Among them, the "Guidelines for the Construction of Enterprise Safety Culture" believe that the basic elements of enterprise safety culture construction include safety commitment, safety affairs participation, independent learning and improvement, code of conduct and procedures, safety information dissemination and communication, audit and evaluation and safety behavior incentive. In the "Enterprise Safety Culture Construction Evaluation Criteria", the basic elements of enterprise safety culture construction include safety commitment, safety management, safety environment, safety training and learning, safety information dissemination, safety behavior incentive, safety affairs participation, decision-making behavior, management Behavior, employee-level behavior.

**Table 1.** List of elements of common safety culture

element	element	element	element
The role of safety regulations	The role of the management system	Safety performance control	Safety training needs
Safe subject responsibility	The role of the security department	Safety performance and human resources relationship	Types of security checks
Safety investment awareness	Leadership accountability	Security system formation method	Safe performance treatment
Work of the security department	Safety attention	Security system implementation	Safety creates economic benefits
The role of security organizations	Safety integrated into enterprise management	Type of accident investigation	Emergency capability

In the process of combing the literature, it is found that most scholars in other industries analyze and summarize the safety culture dimensions and elements in their fields through various channels, and then use mathematical methods to test these elements to find out suitable and effective elements to form an indicator system or measurement model. This approach also provides a method for studying the elements of shipping safety culture.

### 3.3. Measuring Methods of Shipping Safety Culture

Due to the abstract nature of the safety culture concept, it is difficult to describe or quantitatively measure it. This is one of the biggest difficulties faced by research experts and scholars in the field of safety culture.

Hofstede et al.(2016) used quantitative measurement tools and methods to analyze safety culture. Because the safety culture measurement tools represented by quantitative questionnaires and experimental measurements have the advantages of high reliability and validity, the vast majority of safety culture measurement is mainly carried out by compiling measurement scales .The US Department of Energy has developed a safety culture measurement system, which contains 88 measurement elements in 13 aspects including safety

awareness, safety self-evaluation, safety management and so on. It also employs a 5-point Likert scale to measure the safety culture among employees in enterprises. After conducting a safety culture measurement on a North American pulp company, Stewart believes that safety culture factors have significant influence on accident rate. By enhancing the safety culture factors, the occurrence of accidents can be effectively reduced. Fu (2009) and others believe that safety culture is a core concept necessary for enterprise safety management, and it can be measured by measurement equipments, which can quantitatively track the progress of enterprise safety culture construction. Yu and others (2005) studied the safety culture measurement scale for China's coal mine enterprises, and used AHP and Fuzzy to measure China's coal mine enterprises, and obtained valuable measurement results. Zhang and others(2009) used questionnaires and system analysis to measure the safety culture awareness of 150 employees in a mining enterprise. The research shows that there are obvious differences in the level of safety culture awareness among different groups. Bai (2009) adopted a quantitative measurement system to evaluate the safety culture of the management personnel of a mining enterprise. There is still a big gap in level.

**Table 2.** Safety culture evaluation methods

Common methods	Principles and steps of evaluation methods	Representatives of experts and scholars
Grade scoring	Set the safety culture evaluation indicators into several levels, and each level is assigned a corresponding score. The evaluator determines the corresponding level according to the actual situation of the company's safety culture, and simply sums up the corresponding scores to obtain the evaluation score.	Chen Weimin , Sima Junjie, etc.
Fuzzy comprehensive evaluation method	Determine evaluation factors, evaluate each factor, determine the weight of evaluation factors, establish a fuzzy relationship matrix, and calculate evaluation results	Tian Shuicheng, Hao Yuguo, Yin Jianhua, Yu Feng, etc.
Balanced scorecard	Determine the evaluation dimensions and indicators, and ensure the comprehensive balance of the safety culture indicators through the setting of the indicators and their weights; through the calculation of the average value and the calculation of the standard deviation, make the safety culture scores consistent and consistent The analysis of the results leads to the current status of the safety culture and the direction of future efforts.	Chen Jinguo , Fang Shengyou, Li Naiwen, etc
Data Envelopment Analysis (DEA)	By keeping the input or input of decision-making units unchanged, mathematical planning and data are used to determine the relative effective production frontiers, then each decision-making unit is projected, and the relative effectiveness of these decision-making units is judged by separating the reading of production frontiers.	He Luxin, Gao Yanfen, Ma Lijie, etc.

### 3.4. Construction of Shipping Safety Culture

The Chinese government attaches great importance to the construction of enterprise safety culture. In 2008, the State Administration of Work Safety organized the "Guidelines for the Construction of Enterprise Safety Culture" (AQ / T 9004-2008) and put forward the overall requirements of enterprises in the construction of safety culture. For instance, enterprises should fully consider its own internal and external cultural characteristics, guide the safety attitude and safety behavior of all employees, achieve safety self-regulation above the legal and government regulatory requirements, and achieve continuous improvement of the company's safety production level through the participation of all employees.

In 2013, the Ministry of Transport of China issued the "Opinions of the Ministry of Transport on Further Strengthening Work Safety", deployed a five-year "safe traffic" creation activity across the industry, and introduced road and water passenger transport, urban passenger transport, and ferry ferries as a key point of safety supervision and management, hazardous chemicals transportation and construction of large-scale transportation projects, vigorously carried out a series of special actions and activities such as "fighting non-government violations" and "safe production month".

Starting from ESCSE (Enterprise Safety Culture System Establish), the theory of enterprise safety culture system construction, Liu (2006) studied "1 concept, 2 parts, 3 types of objects, 12 guidelines, 4 stages, 8 major influencing factors" of the safety culture, and systematically analyzed various aspects involved in the building of enterprise safety culture. Sun (2007) believes that the basic approach to the construction of safety culture is the construction of concepts, the strengthening of leadership, and the construction of propaganda and education. From the perspective of system thinking, Fu Jianhui interpreted the hierarchical, integral and dynamic balance characteristics of safety culture, and then proposed the construction of enterprise safety culture from the aspects of safety information management system, system security technology and system security education. Fu (2013) believes that once the definition of safety culture is clear, its construction goals and objectives are simple and easy to understand. The purpose of construction is to prevent accidents, and the goal of construction is to improve the understanding of safety cultural elements or safety concepts. With an improved understanding, employees can actively apply ideas and ideas in their daily work and practice to improve safety performance.

In recent years, the theoretical exploration of the construction of safety culture in China has achieved great results, and has also promoted the development of enterprise safety production in practice. Due to the different experiences of the scholars and the surrounding environment, the methods and ideas of the safety culture construction also vary greatly. The definition of the safety culture construction system in the domestic academia has not yet reached a perfect and unified standard, and the safety production norms and standards that companies in various industries follow are different. The question of how to carry out the construction of safety culture more effectively and realize sustainable safety development of enterprises needs further research and discussion.

## 4. Research on Safety Culture and Its Branches

The study of safety culture has been paid more and more attention by government agencies, experts and scholars, and a new comprehensive subject direction-safety culture has emerged. In theory, safety culture is a cross-synthesis of safety science and culture. In the national standard "Disciplinary Classification and Code" (GB / T 13745-2009), it belongs to the safety social science of safety science and technology (code 62021)

In China, the researches on safety culture subjects are mainly Wu Chao, Wang Bing and Tan Hongqiang of Central South University. The main research achievements are the research

objects, research scope, research content and research purposes of safety culture, as well as research methodology, principles of safety culture, discipline branches and discipline extension. The main documents include "Safety Culture", "Safety Culture Outline", "Definition, Characteristics, Functions and Structural Systems of Safety Culture Industry" "Study on the Establishment of Safety Folk Culture" "Study on the Construction of Safety Culture Semiotics" "Safety Planning Construction and Application of Science "" Research on the Establishment of Comparative Safety Culture "" Research on the Method of Safety Culture "" Research on the Establishment of Comparative Safety Ethics "" Research on the Construction of Safety System Management ".

With the refined social division of labor, there may be more branches of safety culture, such as family safety culture, industry safety culture and public safety culture, to supplement the theory of safety culture and enrich the safety culture. Theoretical knowledge and practical scope. Shipping safety culture may also become an independent scientific system to serve and guarantee the smooth development of the shipping industry.

## 5. Conclusion and Prospect

To conclude, although the definition of the safety culture of shipping enterprises is not yet clear, and the boundaries of the safety culture are not clear, it is certain that the safety culture of the shipping enterprises is to prevent and control accidents by affecting human behavior, and it can be determined that the safety culture is a means of controlling people's safe behaviors by shipping enterprises. Research on the safety culture of shipping enterprises has important practical implications for improving shipping safety.

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