Marine Policy 44 (2014) 179–186

Contents lists available at ScienceDirect

Marine Policy

journal homepage: www.elsevier.com/locate/marpol

Relationships between safety culture aspects – A work process to enable interpretation ☆

Åsa Ek *, Marcus Runefors, Jonas Borell

Ergonomics and Aerosol Technology, Department of Design Sciences, Faculty of Engineering, Lund University, PO Box 118, SE-221 00 Lund, Sweden

ARTICLE INFO

Article history:
Received 19 March 2013
Received in revised form
15 August 2013
Accepted 16 August 2013
Available online 11 September 2013

Keywords:
Maritime safety
Safety culture
Safety management
Cluster analysis

ABSTRACT

Knowledge about the existing safety culture in a maritime organization such as in shipping companies or on board ships can enable the formulation of effective interventions to maintain and improve safety culture and safety in the organization. When assessing the safety culture, questionnaires developed for this purpose are often used. This paper proposes a work process that facilitates the analysis and interpretation of the relationships between safety culture aspects using questionnaire data. The work process includes the use of variable cluster analysis where the cluster solutions are presented in dendrograms. These were found to be an excellent way to visualize complex relationships in the quantitative data and to facilitate the understanding of the safety culture concept. Results are presented from applying the statistical process to safety culture data from six Swedish ships in international traffic. The visualized safety culture results can enable group discussions about safety on different organizational levels and can constitute an important input to the continuous improvement processes for safety and safety culture.

1. Introduction

Although mortality rates for seafaring have declined greatly over the course of the 20th century, seafaring has continued to remain amongst the most hazardous of occupations. Merchant shipping is known to have a high rate of fatalities caused by occupational accidents and maritime disasters [1,2]. Human and organizational factors account for the vast majority of unanticipated significant problems associated with the design, construction, and operation of ships. For example, Moore et al. [3] found that most accidents result from a compounding sequence of breakdowns in physical components, human error, and organizational failures.

Technology and automation are often introduced to increase efficiency and safety, reduce workload, reduce human involvement and the effect of human error. However, the human-automation interaction can have consequences for human work and safety as the automation can create new error pathways and delay opportunities for error detection and recovery [4]. The human role in the system is complex since a person's individual characteristics and states, abilities and competencies affect decision-making and performance on board. The human in the system is both error inducing and an important source of expertise for decision-making and recovery [5].

While the human and system aspects are vital for safety, the organizational aspect also has a fundamental influence on safety [6]. The capsizing of the *Herald of Free Enterprise* just outside the Belgian port of Zeebrügge in 1987, with the loss of 193 lives, is one important example. It emphasizes the organizational aspect of having a poor safety culture on different levels in a shipping company [7]. Corporate safety cultures shaped by the degree of commitment to safety on the management level are often highlighted as the overriding factor for safety performance. Conflicting safety and production goals, ineffective communication, time pressure, and fierce competition in a complex industry environment, can very likely lead to the stretching of safety margins (often unconsciously), and the migration of behavior towards the boundary of acceptable performance [8], also known as a "drift into failure". A safety culture that stresses proactive measures for maintaining safety in an organization is a vital counterforce to the possible drift into failure. Thus, to maintain and improve safety and efficiency in safety critical maritime organizations, knowledge is needed about the safety culture and the way it is expressed in attitudes, behaviors, and artifacts. Questionnaires developed for this purpose are often used when assessing an organization's safety culture. The analysis and interpretation of questionnaire results can provide more knowledge about the maritime safety

* Corresponding author. Tel.: +46 46 222 8045; fax: +46 46 222 4431.
E-mail address: asa.ek@design.lth.se (Å. Ek).

0308-597X/$ - see front matter © 2013 The Authors. Published by Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.marpol.2013.08.024

culture concept and contribute to the formulation of effective interventions to maintain and improve safety and safety culture on board ships.

This paper proposes a work process that facilitates the analysis and interpretation of the interrelationship between safety culture aspects in an organization using questionnaire data. In the process, safety culture results are visualized in dendrograms, which facilitates the combination of a qualitative understanding of the phenomenon of safety culture and quantitative evidence from questionnaire data. The visualized results can enable group discussions about the safety culture and serve as an important input to continuous improvement processes. This paper also presents safety culture results from applying the work process to questionnaire data from six Swedish ships in international traffic.

2. Safety culture and safety management

Before describing the proposed work process, theoretical assumptions and notions about safety culture and its relationship to safety management will be presented.

A safety culture reflects individual, group and organizational attitudes, values, and behaviors concerning safety. Safety management relates to the formal safety practices and responsibilities documented in a safety management system. A well-developed safety culture in an organization is an enabler for maintaining and improving safety performance, the emphasis placed on safety work and improvement processes for safety [6]. Safety culture has been shown to be a robust leading indicator or predictor of safety outcomes across industries and countries [9–11]. Research indicates that organizations and companies that have well-developed, functional and proactive health and safety management are likely to experience fewer work-related accidents and incidents [12]. The important reciprocal relationship between safety culture and safety management is emphasized in Cooper's [13] model of safety culture. It encompasses subjective internal psychological factors (i.e., people's attitudes and perceptions of safety and safety culture), observable safety-related behaviors (safety performance) and objective situational features (e.g., structure of the organization, safety management systems, and working procedures) [13].

Definitions of safety culture usually include a proactive stance to safety [14]. Learning in an organization is also associated with a proactive approach to safety. This means collecting, monitoring, and analyzing relevant information on safety and health and thus having updated knowledge about how work and safety are functioning. In this way, a learning culture [6] is created where one learns from the safety information gathered and reported, and is willing to introduce changes when needed.

2.1. Safety culture and safety management in the maritime setting

The International Maritime Organization (IMO) stresses the importance of safety culture on vessels, in shipping companies and in the shipping industry as such. The IMO states that "An organization with a 'safety culture' is one that gives appropriate priority to safety and realizes that safety has to be managed like other areas of the business. For the shipping industry, it is in the *professionalism* of seafarers that the safety culture must take root." This professionalism is determined by attitudes and performance, very often shaped by the culture of the shipping company [15].

The IMO also stresses the importance of safety management systems in shipping. And, in accordance with Cooper's safety culture model, IMO recognizes the bi-directional link between safety culture and safety management. The IMO's International Safety Management (ISM) Code provides a standard for the safe management and operation of ships and for pollution prevention. The ISM Code is mandatory and establishes safety management objectives. It requires that a safety management system be established by whoever is responsible for the operation of the ship. The philosophy underlying the application of the ISM Code supports and encourages the development of a safety culture in the shipping industry. The Code constitutes a system of self-regulation of safe ship operation as well as occupational safety and health on board. The Code requires procedures to ensure safe operation, the management of risk, procedures for reporting and analyzing accidents and conformities, and procedures for internal audits and reviews [16].

The efficacy of the ISM Code has been investigated in several studies but no definitive indication has been provided. Tzannatos and Kokotos [17] found that the Code had a positive outcome in Greek shipping. After examining accidents involving Greek-flagged ships between 1993 and 2006 (i.e., before and after the implementation of the ISM Code), the implementation of the ISM Code led to an overall reduction of human-induced accidents (from 64% to 52%), although Greek-flagged ships still maintained their dominance in shipping accidents. In the pre-ISM period, tankers and Ropax vessels were also deeply linked to human-induced accidents, but implementation of the ISM Code managed to remove this link [17]. However, the ISM Code has been criticized because of the increased amount of paperwork and bureaucracy. Moreover, the standardization of the management of safety and the demand for written procedures are perceived by many seafarers as going against common sense, experience, and the professional knowledge of seamanship [18].

For effective self-regulation of safety and occupational safety and health to be achieved, the implementation of safety management systems must go hand in hand with employer's safety commitment and employee's participation in safety management decision-making [19]. These factors are very much associated with the safety culture in an organization. Employee participation in decision-making will enhance their commitment to take action and implement changes when needed [20]. Good communication and listening skills across organizational levels, groups and individuals strengthens a shared situational awareness of risk and safety [21]. Effective communication and employee participation are also factors that drive organizational change [20,22]. Effective employee participation is often hindered by job insecurity, which correlates with poor communication between employees and managers [23].

Bhattacharya [24] examined if employment and social conditions that support effective implementation of self-regulation are present in the maritime context. The study showed that managers and seafarers were operating with fundamentally different understandings of the purpose and use of the ISM Code, resulting in a gap between its intended purpose and practice. A critical factor was the lack of seafarers' participation in the management of workplace health and safety, which was traced back to the seafarers' poor employment conditions (job insecurity) and low-trust relationships with their managers [24]. In the study the seafarers feared being blamed for shipboard incidents and near-misses which led to poor communication and under-reporting. A critical part of a safety culture is the establishment of a just culture in which responses to incidents and accidents are considered to be just. This creates an open and reporting culture.

Efficient safety management systems all include the collection of safety information from the operational production system in order to learn from accidents and incidents and thus provide a basis for continuous safety improvement [6,25,26]. Studies show that under-reporting constitutes a major problem in the maritime industry [27–29]. Oltedal and McArthur [30] found that a higher reporting frequency in the Norwegian merchant fleet was related to enhanced safety training, a trusting and open relationship