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Learning from the Positive – Suggestions for Potential Improvements to Maritime Safety Management Approaches

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ABSTRACT

Shipping can be considered as a high-risk domain in which adverse events may cause serious disruptions in the global supply chains. This article focuses on approaches to safety management in the shipping domain from a ship and shore perspective. Ten experts from the Swedish shipping cluster have been interviewed to explore current SMS approaches. The results show that shipping should be considered as complex socio-technical system, in which an additional layer of complexity is added through the regulatory frame. Managing safety has increasingly become about administrative tasks to ensure compliance with regulations rather than about enhancing safety at work. To compensate for these experienced gaps, a set of questions based on the Resilience Assessment Grid (RAG) have been developed. The aim of this work is to contribute to a complementary approach to common SMS approaches as well as to lay ground for a deeper cooperation between ship-based and shore-based management.

KEYWORDS

Safety management, Resilience Assessment Grid, maritime safety

INTRODUCTION

The shipping industry can be regarded as high-risk industry, which is fairly safe (Hetherington, Flin, & Mearns, 2006). However, as shipping is the backbone of today's globalized society incidents, accidents or other adverse events may cause severe disruptions in the global supply chains as shown by the recent grounding of the MV Ever Given in the Suez Canal. It is estimated that the grounding has caused a cost of 6 to 10 billion USD and affected unumerous businesses through the stop in cargo transport from Asia and the Middle East (BBC, 2021). This incident does not only show the dependency of society on shipping, but also exemplifies the complexity of shipping itself – cargo owners, shipping companies, maritime administrations and the general public were all affected by the grounding of a single vessel.

Since the introduction of the International Safety Management (ISM) Code through the Internatonal Maritime Organization (IMO) in 1993, every shipping company is mandated to have a safety management system (SMS) (IMO, 2021). However, recognizing the large variety of operations, vessel types and companies, the ISM Code does not prescribe a single format for the SMS, but leaves the design and implementation to the companies themselves. Despite safety management being regarded as important to ensure safety in operations, there is still a limited amount of research about this considering complex maritime socio-technical systems (Schröder-Hinrichs, Praetorius, Graziano, Kataria, & Baldauf, 2015). Further, it is pointed out that there are tendencies for new issues relating to the current safety management approaches arising due to unfit procedures and a heavy documentation load that keeps growing (Størkersen, Thorvaldsen, Kongsvik, & Dekker, 2020).

This article focuses on safety management in the shipping domain to explore whether, and if so how, concepts from resilience engineering can help to complement and enhance current approaches. The following questions have guided this research;

1. What characterises the safety management approach in the companies?
2. How is the SMS operationalised within the companies and how does the staff ashore and onboard work with it?
3. What potential complement for the safety management approach can a resilience engineering perspective offer to the companies?

Safety Management in the shipping domain

Safety management in the shipping domain is regulated through the ISM Code (IMO, 1993; 2021), which was formulated in the late 1980's after a series of accidents, amongst others the capsizing of the ferry Herald of Free Enterprise, pointed towards organizational deficiencies and a lack of safety management procedures. The ISM Code requires all shipping companies to have a SMS (IMO, 1993). A SMS is defined as "a structured and documented system enabling Company personnel to implement effectively the Company safety and environmental

protection policy." (IMO, 1993). While the regulation in itself does not specify the details of the SMS to be implemented, it still presents a framework that companies have to adhere to.
According to Størkersen et al. (2020) and Teperi, Lappalainen, Puro, and Perttula (2019), the ISM Code has had split effects on safety within the shipping industry. On the one hand, it has made shipping safer, on the other hand it has created new risks, such as too much paperwork that may overshadow and infringe on other important tasks. Furthermore, safety-related studies have often been characterised by a retrospective approach to safety, i.e. focusing on mishaps and error rather than on the human contribution to safety. This is also emphasized in Schröder-Hinrichs, Hollnagel, and Baldauf (2012) who discuss that the shipping industry and its regulatory bodies often try to explain and implement measures that are fitted to parts of the system rather than looking at the whole of the system and its complexity (Schröder-Hinrichs et al., 2012). Acknowledging shipping as complex sociotechnical system allows to recognize the importance of adaption and operational context in day-to-day work highlighting the human contribution to the systems' functioning and thus everyday complexity (Schröder-Hinrichs et al., 2015). Therefore, a complement to the commonly applied retrospective approach to understanding and managing safety is needed.

RESILIENCE ENGINEERING

Since the early 2000s, resilience engineering has gained increased recognition as an alternative approach to understanding safety in sociotechnical systems. The term resilience originally stems from ecology where it describes a system's or organism's ability to derive an equilibrium under changing environmental conditions over time (Holling, 1973). Within the resilience engineering framework, resilience refers to a system's, organization's or team's ability to maintain functioning under anticipated and unanticipated circumstances (Hollnagel, 2018).
It thus highlights the sociotechnical systems' ability to adapt to and cope with wide variety operational conditions - expected as well as unexpected ones (Hollnagel, 2018; Woods, 2006). In comparison to traditional management approaches, resilience takes the complexity of a system into account and emphasizes the need to widen the objectives to more than the prevention of incidents and accidents. It represents a novel approach to the understanding and management of safety (Bergström, van Vinsen, & Henriqson, 2015; Hollnagel, 2018; Hollnagel & Woods, 2006; Provan, Woods, Dekker, & Rae, 2019). It also offers a new perspective on what makes systems cope with the known and the unknown, as well as the unexpected (Dekker, 2006; Hollnagel, 2018). The focus is on day-to-day operations, or work-as-done (WAD), and on what goes right rather than focusing on work-as-imagined (WAI) or prescribed. Included in this is the understanding of how safety as a balancing act can be affected by different stressors and cause the operation or the system to move towards unsafe behaviour or situations (Dekker, 2006; 2018). Furthermore, it is also suggested that resilience has the potential to complement earlier safety management by making it possible to detect the move towards unsafe, or unwanted, behaviour or situations in advance (Dekker, 2006; Hollnagel, 2018).
Resilience is often described with the help of the four cornerstones; respond, monitor, learn and anticipate. Respond, or knowing what to do, is about a system's ability to handle what is both common and uncommon turns of events (Hollnagel, 2018). It is also about being able to respond to opportunities to be able to create advantages for the system (Hollnagel, 2018). Responding is done by performing set measures, adapt present operations or by finding new ways of operating (Hollnagel, 2018). Timing is of the essence for responding to work as intended. (Hollnagel, 2018). Monitor, or knowing what to look for, is observing what is happening within the organisation, as well as outside of it, to enable responding with the appropriate measures at the appropriate time (Hollnagel, 2018). To be able to monitor, the organisation needs to have identified indicators that provide information about what is going on (Hollnagel, 2018). Being able to learn is what makes an individual and organisation cope with changes in the environment where daily operations are performed (Hollnagel, 2018) and lastly, dew ability to anticipate is about knowing what to expect and envisioning the future and preparing for it (Hollnagel, 2018). Knowing what to expect is about looking further ahead than monitoring and using the possible future events to be able to handle possible future events (Hollnagel, 2018). Despite the fact that resilience has gained increased popularity within the safety community, the methodological approaches are yet limited. Commonly the Functional Resonance Analysis Method (FRAM) is used to understand adaption and coping behaviour of large-scale systems in a variety of high-risk domains, while the Resilience Analysis, or Assessment Grid (RAG) has mostly been used to assess organizations (Patriarca, Di Gravio, Costantion, Falegnami, & Bilotta, 2018)

The RAG has been developed in early 2010s as a response to the need for a deeper understanding of organizational resilience, or what enables resilient performance of a system (Hollnagel, 2011). Thus, the RAG is a proxy measure (Chuang et al, 2018) of the four resilience abilities and builds on a set of questions, sometimes a questionnaire, which are adopted and translated for a specific domain of application (Hollnagel, 2018; Patriarca et al 2018). It is thus one of the few approaches operationalizing the four abilities. The aim of the RAG is to assess an organisation's potentials for resilient performance "here and now" to enable the possibility to compare that to where the organisation wants to be and to further develop areas where shortcomings have been identified (Hollnagel, 2018). Despite the increasing recognition of resilience as complementary approach to safety management, the application

of the RAG is still limited to few studies in domains such as healthcare (Chuang et al, 2018; Patriarca et. Al,), construction work (Peñaloza, Saurin, & Formoso, 2020), or aviation (Sekeľován & Lališ, 2020)

In this study, a set of questions for each ability has been developed to complement current approaches to safety management in the maritime domain.

METHODOLOGY

This study has been conducted as a multiple case study with multiple persons from more than one company have participated in the study (Merriam, 1994). A case study design is appropriate when the aim of a study is to gain insights into the context of the case and the studied area (Merriam, 1994). The aim of the study was to gain insights into the characteristics of the safety management of four shipping companies.

To be able to understand how safety is managed, it becomes important to get perspectives from respondents who work with safety, as well as impact its implementation and realisation. Thus, persons involved in the safety management ashore and onboard were participating in this study. It is furthermore the intent of this study to explore if resilience engineering can offer potential improvements to the current safety management. The understanding of the reality that the companies and their crew operate in, i.e. the context, is important in order to be able to come to conclusions regarding whether resilience engineering can offer potential improvements. The data was gathered through semi-structured interviews. Semi-structured interviews were chosen because of the possibility to get answers to specific questions, while at the same time being able to follow up on different aspects expressed during the interview that can be of relevance to the results (Bryman, 2018).

Participants

A total of ten respondents from five companies participated in this study. Five of them worked at company offices ashore. Four of these were DPs and one was a Safety Officer. The other five worked onboard ships as either chief officer or chief engineer. The respondents from the shore-side either worked in a shipping company or ship crew management company where they handle crew management as well as technical management of ships. The shipping companies either transport goods or goods and passengers. All respondents represent their companies at different levels; ashore and onboard and they have from 12 to 45 years of experience within the shipping industry.

Semi-structured interviews

Ten semi-structured interviews were conducted. Before performing the interviews, interview guides were developed. One type of interview guide was formed for the participants working ashore, and one for the officers onboard. After the background questions, the guides were more directed towards safety work and safety management from the outset of the roles of the respondents. In short, the areas of coverage of the questions were;

- Safety work; how is it done, what are important factors to safety work, what parts of the safety management system is the respondent involved in and how is this put into practice in everyday work.
- Incidents/accidents; questions about the handling of incidents and accident reports, example of when a report has led to a change in the safety management system.
- Education; regarding whether the respondent has partaken in further education regarding safety and whether this has brought with it any gains in terms of work with safety.
- Desired change; question regarding what the respondent would change, add, or remove regarding the current safety management if they had the means to do so.

All interviews were transcribed verbatim. The transcribed data from the interviews were analysed with the help of thematic analysis (Bryman, 2018).

ANALYSIS AND RESULTS

Safety management in the maritime domain

The Swedish shipping industry can be characterised as a complex socio-technical system. The complexity of the system emerges in several instances such as the regulatory aspects, the organisational frames of the companies involved in a ship, as well as the ships themselves and what services they perform. In other words, there is regulatory, organisational and operational complexity. Regulatory complexity arises from several levels of codes and regulations, in addition to national laws and provisions. Thus, if a ship owned by a Swedish company sails under the flag of another nation, the flagstate, i.e. the country where the vessel is registered, is what applies onboard that ship. This creates regulatory factors that are deemed to be hard to overview, as well as to see how they impact one another. It is expressed one of the respondents that there are *"great quantities"* of regulatory bodies to comply with and that few industries are as well-regulated as shipping. Furthermore, the respondents also perceive it to be preferable to have international laws and regulations instead of national ones since that creates different *"rules of*

the game". Organizational complexity is created by the number of stakeholders involved in managing a ship as expressed in the quote below.

> *"There are so many stakeholders in a ship since it so much money involved, so there can be x number of owners and then there is someone who has the commercial responsibility, someone who has the technical responsibility and then someone who is responsible for the crew and then someone who handles insurance […]" (DP)*

Other aspects that give raise to complexity in this domain, are the operational factors such as the ships themselves and the cargo they carry. A ship is a system with sub-systems such as crew, technology and machinery. Furthermore, a ship can be carrying goods, passengers or both goods and passengers. There is a vast amount of technology and machinery, including engines, that have to function on a ship, or it will be unable to navigate or move. Malfunctions of technology or engines create different risks depending on where at sea the ship is. Adding onto this are contextual aspects, such as weather, which are beyond control.

Safety Management ashore and onboard

The safety management approaches identified in this study are characterized as reactive safety management (Bergström et al., 2015; Hollnagel & Woods, 2006; Provan et al., 2019), where the focus is on compliance of the Safety Management System (SMS) with the ISM Code.

The SMS is explained to involve routines and procedures for how things are to be done to ensure safe practice onboard. These procedures and routines range from how to enter a port, or how to perform a fire drill, to when a certain equipment has to be checked and how. In other words, there are routines and procedures for all elements included in the operations onboard. Regarding how safety is managed on the different levels in the companies, the respondents emphasize that their job is for the mostly about ensuring compliance with rules and regulations.

The work ashore mostly focuses on how to manage risks and investigate whether an adverse event has been caused by deviations from routines and procedures. Alterations in equipment or in the cargo that is being handled, along with revisions can also cause changes to routines and procedures. Internal audits and reports that are sent into the SMS can be used as an indicator on whether routines are followed or not. If they are not being followed, then either the routine is changed, or other procedures are put in place to ensure compliance with the original routine.

In comparison to safety management and safety work onshore, onboard operations are described as a mixture of following rules and regulation and relying on common sense. Further, safety in operations often depend on other factors than the regulatory framework. An example of this is that there can be set rules and routines for the usage of safety equipment and safety gear, but then you have the issue of getting the crew to understand why they should use it, and that this is a way in which they affect their own level of safety when performing a task onboard. Further, the officers discuss that the SMS has become quite large and that there is a risk of being oversized and containing too much and although the system is electronic, it creates a lot of paperwork.

Another respondent working onboard also questions the fit between the SMS and actual operations. It is explained that the documents that have been written in the SMS are more about having a lot of text written, then actual useful content.

It is expressed by both groups of respondents that routines and procedures are the foundation of the safety management and safety work. The reliance on routines and procedures along with the mentioning of codes and provisions when discussing "why" these exist, creates the impression of a safety management is to a large extent reactive. It is further highlighted that statistical data of the past year's incidents and accidents are what forms the upcoming year's safety focus. This shows tensions between the experienced reliance on rules and routines, as well as an awareness for or questioning of their applicability to the operational context. This indicates the need of making trade-offs between rules, routines, and the contextual factors that impact on WAD. Furthermore, it is expressed by two of the DPs that they would like less bureaucracy and a simplification of regulations, while two of the officers onboard state that they would like more control over routines. They also express the need for a better fit of the SMS with operations, as well as of it consisting of less text. Other respondents discussed the better time management regarding the safety drills, the reach of the emergency helicopters, and how lifeboats are situated onboard - as areas for potential safety improvements. The master's effect on operational safety was also emphasized as well as time for crew involvement in safety work needs to be set aside.

The range of issues regarding safety that is brought up by the respondents, can be said to give some insight to the complexity of the companies, the industry they are part of, and safety. There are several meanings to the term safety as well as there being many aspects and factors that affect it. It could be argued that the respondents have highlighted the issue of bureaucracy and levels of paperwork that affects how well the routines and procedures are fitted to the actual operation as well as the matter of time for being involved in safety work and safety drills.

Enhancing Resilience Capabilities

The data collected from the interviews were also analysed and coded from the outset of what could be incentives of resilience Engineering. The codes were formed into themes and expressed in the terms of the four potentials for resilience as stated by Hollnagel (2018). The indicators that were found that could be said to represent one or more of these abilities are illustrated in figure 1 below. The result of the analysis of each sub-category shows that

there are elements that suggest the presence of most of the potentials for resilience, however, they vary between roles as well as to what extent they are present.

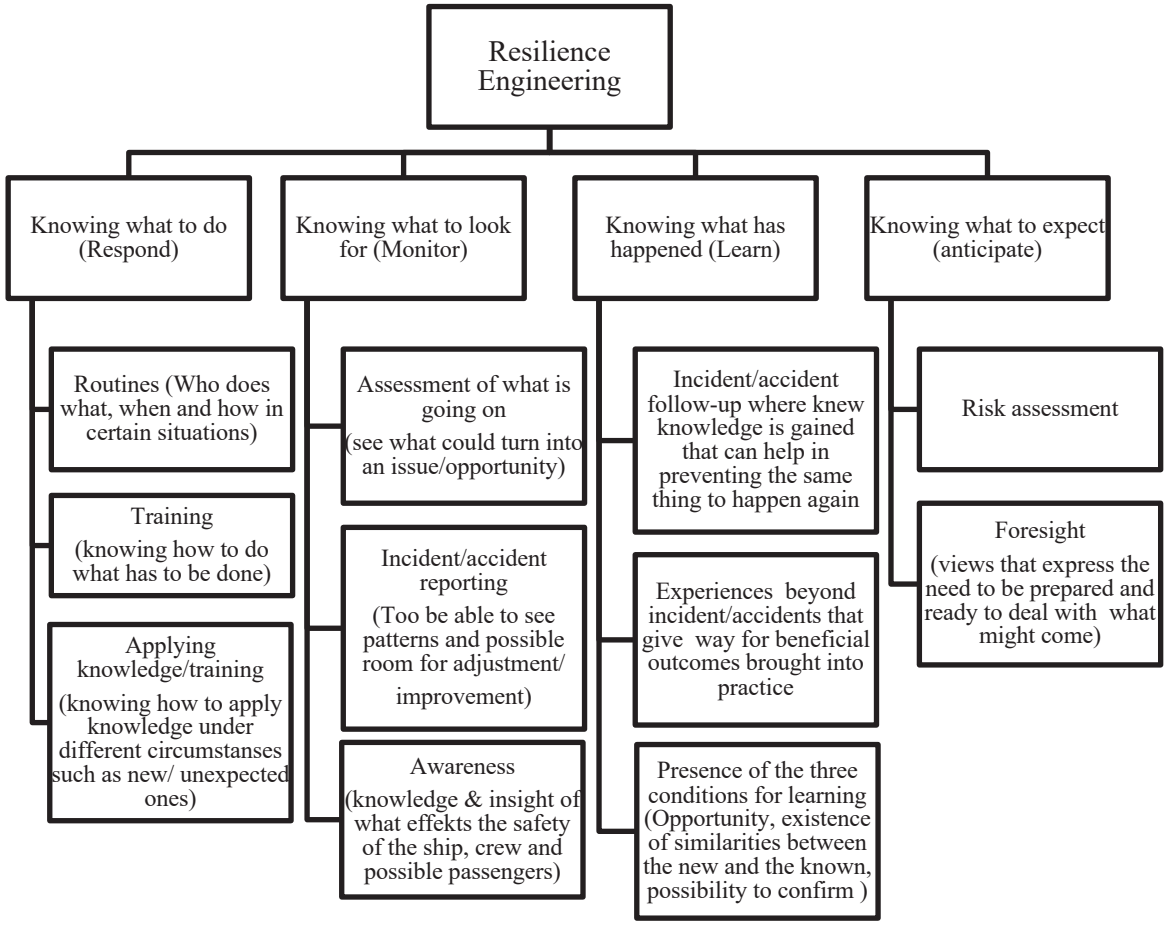

Figure 1. The four cornerstones for potential for resilience and the incentives thereof from the outset of the answers in the study.

Knowing what to do - respond

This sub-category was built on the codes that indicated the presence of "routines", "training" and "applying training". Routines are an indicator that is mentioned by all respondents, i.e. all respondents mention working with and having routines to follow regarding safety in their line of work. Training is an indicator that is present for the ones working onboard. With regards to "applying training", it was not possible to state whether what is trained is actually used in practice or not. This could be due to most of the training being either related to certification or mostly focused on emergency drills of some sort.

Knowing what to look for – monitor

This sub-category comprised of codes that indicated the presence of "assessment of what is", "reporting" and "awareness". "Assessment of what is" means the assessment of safety from the outset of the reality that the respondents perform their work in. This includes issues, as well as opportunities. "Awareness" refers to knowledge and insights of what affects safety of the ship, crew, and possible passengers. Reporting means that there is a system for making and following up on reports that are used with the intent of ensuring safety.

Here the data was insufficient to be able to state whether the DPs or safety Officer had the ability of "assessing what is", as well as in the case with one of the Chief Officers. However, in the case of three of the Chief Officers, it was possible to see that they assess "what is". At least three of the Chief Officers stated examples of how they could perform things in a safe way for both themselves, the crew, and the ship, i.e. they have "awareness". Examples of this is their statements regarding how they prepare for and carry through loading and offloading as well as factors that affect safety. Reporting is also part of the ability to monitor as stated by Hollnagel (2018). The officers have the possibility and the means to do so. There is a system available for making and sending in the reports to the safety department, or to the DP. Being able to report is required by the ISM code. The ability of assessing "what is" and being aware of what consequences a situation or action can result in, are deemed to be abilities of a person and a competence.

Knowing what has happened – learn

This sub-category was based on the indications of whether there could be said to be report follow-up, experiences beyond reporting and presence of the three conditions for learning. Report follow-up refers to be that new knowledge is gained that can help in preventing the same thing from happen again. Experiences beyond reporting relate to factors or events other than incidents or accidents that give way for beneficial outcomes brought into practice. The three conditions for learning are opportunity to learn, existence of similarities between the new and the known and possibility to confirm that what was taught actually was learned and could be used (Hollnagel, 2018). The data suggest that all respondents use and perform "report follow-up" in the sense that they check that what is reported has been followed up by a suggestion for adjustment or measure, and that if the adjustment or measure is stated to be done, then the report is closed.

The first aspect of learning is "opportunity", and there are deemed to be opportunities for all respondents to learn. The DPs learn from either the day-to-day work, where an example could be the report follow-ups and audits and reviews. Furthermore, there are opportunities to learn from others in the same position as well as partaking in courses to further build knowledge in areas that are part of the role as DP.

Knowing what to expect - anticipate

This sub-category was based on whether there were risk assessments being performed. Here risk assessment refers to the assessment of what risks a work task or procedure would entail in relation to what unwanted events and accidents that might happen. Furthermore, it is also an assessment of what the likelihood of them happening is. Also included in this sub-category is foresight which here has the meaning of views that express the need to be prepared and ready to deal with what might come. Risk assessments are performed after either a risk has been detected, an issue has been raised during a safety committee meeting, or if new equipment has been introduced and if there has been changes to operational factors. Regarding foresight, five of the respondents provide examples for what could be considered as foresight. These five respondents show through their reasoning how they so to speak "think ahead". One respondent expresses the value of the conferences with other DPs where they can learn from each other and save resources such as resources, including people.

"To be able to learn from each other in this way is incredible because it spares both people and other resources […]" (R2)

Another respondent expresses the need to be prepared when out at sea by having enough amounts of fuel, both for the engines and the generators that provide the ship with electricity. Another aspect expressed is that of having spare parts since without them, the ship could be dead in the water for days before help arrives.

Resilience Statements for SMS Reflection

As outlined above, the SMS approaches practiced in the maritime domain are to a large extent reactive. There is also evidence of a gap between shipboard operations and shore-based company management, which consequently leads to a situation where the staff onboard manages safety based on what works, not what is included in the formalized system. To close this experienced gap between WAD and WAI, it is necessary to complement current SMS approaches. One potential complement could be the use of items developed based on the RAG. Table 1 below shows a first set of statements developed based on identified gaps in the analysis above.

Each statement can either be used as trigger question for joint working groups with representatives from the ship and the shore organization, or they can be used to obtain a snapshot of the current potential to resilient performance of the shipborne operations. In the latter, a Likert-scale can be developed to enable a quantification for each item, which can be translated into a visualization similar to those presented in (Chuang, et al., 2018)

Table 1: Statements for each capability based on the RAG

Respond	**Monitor**
There are sufficient Standing Operating Procedures to support the crew to handle regular and irregular events, including emergencies	The organizational resources (Procedures, guidelines and checklists) are regularly updated based on feedback from the crew
There are sufficient resources (people, technology, other materials) to enable a prompt response to sudden changes in the operations	There is a common understanding on when to adapt different strategies to maintain the capacity to respond to sudden changes in the operation
The organizational resources (procedures, guidelines, work description etc) support the crew effectively in everyday work	There are procedures on how to collect data on performance in everyday work
There are procedures on how to (re)prioritize, and match required resources (technology, people, other materials) to the current work situation	Indicators for safety reflect the crew's contribution to safety, not only to risk and accidents
	Indicators for safety in operations are formulated in cooperation with junior and senior crew members from different departments onboard
Learn	**Anticipate**
There are procedures for how to identify and collect events for learning	The crew is included/asked before changes (technical, organizational) that may affect safety are implemented
There is enough time and resources to regularly train for emergencies	There are guidelines on how to update the SMS based on feedback from the crew

There is enough time and resources to regularly improve training There are opportunities to share lessons learned, both negative and positive, a) among the crew b) within the company Training needs analyses are conducted regularly to identify ways on how to enhance the crew's potential to respond and monitor	The SMS is regularly audited in a joint working group with representatives for ship and shore operations The crew is encouraged to raise potential and anticipated safety risks

DISCUSSION

This article has explored the potential to complement common safety management approaches in the maritime domain from a resilience engineering lens. The results and analysis show that shipping should be characterised and treated as complex sociotechnical system, with complexity arising from regulatory, organizational and operational factors. Thus, a Safety I approach as currently practiced in shipping, focusing on adverse outcomes to generate routines and procedures that are intended to prevent the same thing from happening again (Bergström et al., 2015; Hollnagel & Woods, 2006; Provan et al., 2019), might be too limited to address the domain's inherent complexity.

Further, the results are in line with findings of Størkersen et al. (2020), who discuss that the vast amount of procedures and documentation potentially creates accidents rather than preventing them. In this study less bureaucracy, a better fit of routines to operations, as well as having more control over them, were mentioned as potential safety enhancements. The want for less bureaucracy and simplification of regulations indicates that the current regulations poses hardship to interpret thus making it hard to comply with them. This also exemplifies the gap between WAI and WAD (Hollnagel, 2018), especially when the respondents stress the need for an operational focus on safety. They mention aspects such as how to ensure safety if the worst happens; possibility to get medical assistance by helicopter or usage of lifeboats without creating further risks as well as resources in terms of time for crew to actually get involved in safety matters. This can be related to the WAD, that the procedures produced through WAI needs to be complemented with WAD. This could also indicate that there still are parts of the operations where safety work has not reached safety of work. It could be argued that the participating shipping companies have reached their limits with regards to having set routines and procedures for all aspects of the operations, since there are factors that will not be possible to anticipate in detail and thus calls for adaptability and the competence to apply previous knowledge to new situations.

The mapping of the data to the cornerstones (monitor, respond, learn, anticipate) show that the current safety management approaches include certain aspects of resilience, but that there is room for improvement. As a complement the RAG-based statements have been developed, which can used by personnel onboard and onshore to trigger reflection on the current safety management approach and to help to identify potential improvements the SMS, as well as to communicate the from ship to shore. The statements are grounded in the data obtained from interviews, but have not yet been evaluated. Thus, a next step in this work is to test these with representatives for the shore and ship organization.

CONCLUSION

Current safety management approaches in the shipping domain are foremost reactive and focus mostly on compliance with the regulatory framework. The findings in this article show that the gap between work-as-prescribed in the SMS and work-as-done in the everyday settings onboard differ and that procedures and rules may affect operational safety negatively. To close this experienced gap, a set of statements have been developed based on the RAG, which may complement current approaches from a resilience engineering perspective. Managing safety bottom up from the operational perspective can create an environment where learning from everyday work is facilitated and the preconditions for resilient performance are provided by the organizational framework. It may also lead to improved communication between ship and shore as well as to more collaborative safety work.

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