Proceduralizing marine safety
- Procedures in accident causation
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The marine accident report is available from the webpage of the Danish Maritime Accident Investigation Board www.dmaib.com.

The Danish Maritime Accident Investigation Board

The Danish Maritime Accident Investigation Board is an independent unit under the Ministry of Business and Growth that carries out investigations as an impartial unit which is, organizationally and legally, independent of other parties. The board investigates maritime accidents and occupational accidents on Danish and Greenland merchant and fishing ships as well as accidents on foreign merchant ships in Danish and Greenland waters.

The Danish Maritime Accident Investigation Board investigates about 140 accidents annually. In case of very serious accidents, such as deaths and losses, or in case of other special circumstances, either a marine accident report or a summary report is published depending on the extent and complexity of the events.

The investigations

The investigations are carried out separate from the criminal investigation without having used legal evidence procedures and with no other basic aim than learning about accidents with the purpose of preventing future accidents. Consequently, any use of this report for other purposes may lead to erroneous or misleading interpretations.
0. SUMMARY

Deviation from procedure is a frequently used factor in accident causation. This exemplifies the belief that safety can be created by means of formalisation. The ISM Code is based on this principle and is the main regulatory tool for ensuring the formalisation of safety and for promoting a safety culture. However, it is rarely discussed how procedures perform as a safety measure.

The Danish Maritime Accident Investigation Board has prepared a report on the proceduralisation of marine safety with the purpose of pointing to problematic issues that occur structurally in the process of moving from the idea of formalising safety to the implementation of this idea in practice.

In the report, the DMAIB concludes that safety management systems mitigate several types of risk besides the safety-related risk, inducing goal conflicts and making the system complex. Furthermore, it is concluded that procedures is a static tool to be used in a dynamic situation. This creates a discrepancy for seafarers to bridge on an everyday basis. In the wake of an accident this will be perceived as an anomaly and a causal factor. Rather than pointing to the seafarers' abilities and will to follow procedures, the DMAIB suggests taking a critical look at the performance of the procedures as a safety measure.
1. PURPOSE AND SCOPE OF THE REPORT

“The accident happened because procedure was not followed.” The Danish Maritime Accident Investigation Board has frequently observed this reasoning in the maritime industry in the aftermath of a marine accident. Furthermore, the DMAIB has observed that, in the wake of an accident, the initiative taken to counter future accidents often involves new procedures. When deviation from procedure is stated as the cause of an accident and future accidents are countered by new or more procedures, it pertains to the idea of procedures functioning as barriers between accident and normal operation. Thinking of procedure as a safety barrier is based on a belief that safety is imbedded in the procedures and formalisation of the operations on board ships. However, it is rarely questioned why people deviate from procedures and whether procedure equals safety. And what is the nature of procedure in the first place?

The notion of procedure tends to be used as a truism – meaning a self-explanatory and uncontroversial notion. But the notion of procedure is far from unequivocal. Procedures can embrace everything from precise instructions for carrying out a task to a general policy statement; it can be specific or abstract. Different types of procedure can have different purposes or even several purposes at the same time. It is crucial to be aware of these differences when using procedures as a tool for managing safety in a constructive manner, and to understand why procedures cannot always be followed.

This report is an investigation into procedures involving shipboard operation as they appear in the safety management system. The report examines the relationship between procedures and safety and aims to initiate a discussion about the role of procedures in managing safety. The starting point of this report is the ISM Code given that the Code recognises the pivotal role of procedures in safety management. The report consists of:

- The historical development of the ISM Code and a background to the Code.
- An observation of the implementation of the ISM Code in practice, i.e. how policies and procedures are applied in shipboard operations.
- An observation of fundamental discrepancies between procedures and the operational context that they refer to.
- An analysis of the notion of procedure as a safety barrier and its linkage with safety culture.
- A summary of the systemic function and implications of using procedures as safety barriers.
- Finally, distinction between procedures as a safety barrier and procedures as a safety measure.

The report is based on observations and interviews made by the DMAIB during accident investigations over a number of years as well as designated field studies and interviews carried out specifically in connection with this report. The case studies and examples used in this report serve as the basis for illustrating the issues related with procedures. It is not the intention to point to inadequate handling of a situation or display shortcomings of companies or individuals related with procedures examined in this report.

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2. PROCEDURE

Procedure is a common word in our everyday language that sounds familiar in most people’s ears to such an extent that we rarely think of what the word actually means. Intuitively, we have an idea of a conventionally agreed-upon meaning, and we find the word procedure self-explanatory and unequivocal. The meaning of the word, however, is not stable. The notion of procedure signifies a conception, and conceptions are in essence debateable and changing. Before investigating how procedures work within safety management systems, it is therefore important to describe and specify the concept of procedure that this investigation deals with.

Procedure derives from the Latin word *procedere* (‘to go forward’) and the simplest meaning of procedure can be reduced to ‘series of acts in a particular order of succession’. However, the most frequent use of the word is in the meaning of procedure as ‘a determined manner of acting or conducting a task intended to achieve a desired result’.

The italics emphasise that layers of additional meaning have been added to the simple form. ‘*A determined manner*’ means that ‘the series of acts’ has been decided and laid down by someone and that the series of acts is given a purpose, ‘achieving a desired result’. Hence, the order of the procedure determines the result and becomes a standard of conduct to fulfil a given purpose.

Within the safety management system, procedure sets a standard of conduct with the purpose of preventing accidents, and thereby creating safety. It logically follows from this assumption that safety is imbedded in the procedure; in other words, safety is created by following the procedure. Phrases such as ‘you must follow the procedures to ensure safety’ popularises a certain way of thinking about procedures to the extent that this becomes the ‘accepted truth’ in society. This form of ‘accepted truth’ can be referred to as the ‘discourse of procedure as a safety barrier’.

By establishing a determined way of conduct, procedures become something to follow: an advice or a command. This means that, within the discourse of procedure as a safety barrier, the notion of procedure does not only refer to a series of acts, but establishes a communicative situation. Procedure constitutes a standard determined by one entity for another to follow.

If the end-user of the procedure does not keep in line with the standard of conduct, then it follows from the discourse’s logic that the consequence will be an undesired result. The statement ‘the accident happened due to a deviation from procedure’ as a conclusion on an accident investigation is an example of the logic in discourse of procedure as a safety barrier. In this way the procedure marks off the area of normative behaviour in a given situation, and deviating from procedure means trespassing the boundary of normative behaviour by moving into the area of unacceptable behaviour. Deviance from procedure within the discourse of procedure as a safety barrier thereby implies a connotation of moral deviance.

Challenging this conventional thinking about procedures will serve as the background for this report.
3. THE ISM CODE

3.1 Background for the formation of the ISM Code

Regulation concerning safety in maritime shipping can – with a historical simplification – be divided into three periods: 1) Before the 19th century, 2) The 19th century up until the 1980s and 3) The 1980s until now (figure 1). These three periods are characterised by three different paradigms; in this context meaning three fundamentally different ways of thinking safety regulation in the maritime industry.

Before the 19th century, maritime regulations were mainly concerned with the protection of commercial interests. Not until the mid-19th century, was the concept of safety institutionalised to minimise the loss of lives and ships at sea. Between the 19th century and up until the 1970s, the number of regulations in the shipping industry increased and extended its reach to international scale. But these regulations dealt mainly with technical innovation, certification of seafarers and prescriptive rulemaking with the aim of minimising casualties at sea. In the 1970s, it became apparent that very serious casualties occurred despite the increased scale of safety initiatives. Attention was being gradually shifted from technical deficiencies to identifying human error as a causal factor behind accidents.

During the 1980s and early 1990s, a number of very serious accidents occurred such as the Herald of Free Enterprise, Estonia and Scandinavian Star. Both the human element and organisational factors were understood as the dominant reasons for these accidents. In response to these very serious accidents, there was general consensus in the maritime industry that regulations concerning safe management were required. This led to the introduction of a new type of regulation that embodied a paradigm shift of thinking in maritime regulation and became the starting point for the introduction of the ISM Code.

Figure 1: Illustration of paradigm shift in maritime safety regulation
Source: DMAIB
The ISM Code was adopted by the IMO in 1994 and ultimately came into force in 1998. Instead of detailed, prescriptive regulation, the ISM Code takes a goal-based approach to regulation. The Code requires every company to develop and implement a formal approach to safety management and pollution prevention. The Code offers a broad framework for safety management systems – exactly how the objectives of the Code are achieved is left to the company responsible for the safety management system.

A key object of designing the Code in this manner was to strengthen the relationship between the onshore and onboard management of ships. The Code acknowledges the diverse nature of ships and shipboard operations within the maritime industry. It allows companies to design safety management systems that are most suitable for their specific requirements within the framework of the Code. It also encourages the onboard and onshore management to take shared ownership of the safety management system with a view to facilitating the internalisation of a safety culture within the company.

3.1 The structure and function of the ISM Code

The ISM Code consists of 1) A preamble describing the establishment, purpose and principles of the Code, 2) Part A describing the requirements for the implementation of the Code, 3) Part B describing the requirements for verifying that companies and ships comply with the Code, 4) Guidelines connected to the Code.

In this report, focus will be on Part A of the ISM Code as this is where the mandatory requirements of the Code are outlined. The implementation of the Code consists of three essential components: objectives, functional requirements, and self-monitoring. These three components may be understood as the scope, composition and dynamic method of continuous improvement of safety management.

3.1.1 Objectives

The objectives of the ISM Code are the basis for defining the scope of the safety management system. This includes promoting safe practices in ship operations; safe working environment; assessing all identified risks and establishing appropriate safeguards against those risks; continuous improvement of safety management skills; and compliance with regulation and other applicable guidelines, standards and codes. In practice the objectives of the safety management system are achieved by establishing procedures, risk assessment, tools for continuous improvement in managing safety and compliance with relevant regulations and rules.

The objectives of the Code are stated in Part A, section 1.2.

3.1.2 Functional requirements

The functional requirements of the Code are the basic operational requirements for setting up and maintaining a safety management system. There are altogether six functional requirements: a safety policy; instructions and procedures for safe operation of ships; defined levels of authority and lines of communication; procedures for reporting accidents and deviances; emergency procedures and procedures for audits; and management reviews. The functional requirements are stated in Part A, section 1.4, and these have been further elaborated in sections 2-12.

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2 The ISM Code concerns both the safe operation of ships and pollution prevention. In this report, reference will be made only to the subject of safe operation. The guidelines are common for both objectives though.

3 The notion of safety culture will be treated in section 7 of this report.
3.1.3 Self-monitoring

In the past, the implementation of regulation has mainly been achieved through penalties and compliance. The owners were either fined or expected to meet the minimum requirements of prescriptive regulations.

However, the ISM Code works on the principle of self-regulation. The Code provides a framework for self-regulation; the discretion to self-regulate is left to the company’s internal verification and monitoring systems. The general framework of the Code consists of a scope (the objectives), a composition (the functional requirement) and, a method of dynamic self-monitoring.

The onus of implementing the safety management system ultimately rests with the ship owner (or manager). It is therefore expected that the safety management system is kept up-to-date with minimum intervention from external regulatory bodies. This is achieved through the process of continuous improvement of the system. The Code requires every company to periodically verify that the system is implemented and operationalised, and that a continuous evaluation and review of the effectiveness of the safety management system is undertaken (figure 2). This iterative process of continuous improvement is intended to maintain high standards of safety.

Self-monitoring as a method of dynamics stems from the idea of self-regulation. Self-monitoring is aimed at ensuring that the strategies and policies of the organisation are aligned with its operational practices. Furthermore, safety management is dependent upon the level of commitment of the company’s management and safety performance is dependent on top-to-bottom commitment within the company. Self-monitoring therefore involves everyone from top to bottom in continuous top-down and bottom-up feedback dynamics. Thus, everyone takes ownership of safety initiatives and the safety culture of the organisation is enhanced.
4. IMPLEMENTATION – FROM ISM to SMS

4.1 Typical document structure of safety management systems

Procedures are one amongst the many types of documents in a safety management system. This section is intended to describe the role of procedures as documents and their relationship with other document types in the management system.

It is a requirement within the ISM Code for companies to adopt a documented Safety Management Manual (SMM) and it is within the SMM that the safety management system is described in further detail. At a higher level, the SMS incorporates policies that ensure the fulfilment of the objectives of the ISM Code. In the next stage, procedures and checklists are established to ensure that relevant policy objectives are met. The organisation of documentation, such as manuals, policies, procedures and checklists, is illustrated in the figure below (figure 3), which shows how different document types are subordinate to each other, and how the number of documents tends to increase with the degree of subordination.

![Diagram of typical document structure in the safety management system](image)

Figure 3: Illustration of typical document structure in the safety management system
Source: DMAIB

The document structure above is illustrative of most quality and safety management systems. Below, we outline the meaning of and the interrelationship between the most commonly used documents in the SMS such as ‘manual’, ‘policy’, ‘procedure’ and ‘checklist’. 
- **Manual:** The purpose of the manual is to provide an overview of the SMS and how it is implemented within the company. The manual is the highest ranking in the hierarchy of documents. The manual can either hold subordinate documents (i.e. policies, procedures, checklists) within or serve as a reference tool.

- **Policy:** Policies are a set of principles by which an organisation is governed and driven. The policies comprise declarations of intent, guiding principles, company “laws”, and core values of the organisation. Polices are developed by the top management both for employees and external stakeholders as a message about “how we do business in this organisation”. Examples may include health and safety policy, environmental policy, quality policy, drug and alcohol policy, etc.

- **Procedure:** Procedure describes a task, when it is conducted and by whom. This is generally achieved by specifying a sequence of sub-tasks or actions. The procedures should be kept consistent with policies. A procedure is typically a message from the managers to the employees about “how we carry out work in this organisation”. The procedures are most often directed to the person responsible for a given task.

- **Checklist:** A checklist is a type of document intended to ensure that certain actions related to a task are carried out. Checklists may be used to decompose high level procedures into a group of tasks and sub-tasks. A checklist is often directed to the end-user (in this case a seafarer) responsible for undertaking a specific task.

In general the safety management manual is set up with each policy statement grouped along with the relevant procedures and checklists arranged thematically in accordance with the relevant sections of the Code. Developing a safety management system that reflects the structure of the ISM Code helps facilitate the implementation of the ISM Code during the initial and operational phases. By following the structure of the Code it becomes easier for companies to demonstrate compliance with the Code internally as well as externally to regulatory bodies and commercial entities.

### 4.2 Establishing procedures in the Safety Management System

Section 7 of the ISM Code requires every company to:

“[…] establish procedures, plans and instructions, including checklists as appropriate, for key shipboard operations concerning the safety of the personnel, ship and protection of the environment. The various tasks should be defined and assigned to qualified personnel”

Identifying the key shipboard operations concerning safety and establishing procedures, including necessary sub-documents, demands considerable resources. Therefore, different strategies for accomplishing this task exist depending on the nature of the ship operation and nature of the company. At one end of the scale, the procedures can be established from scratch within the company itself or for a specific ship. At the opposite end of the scale, a set of generic procedures or a set of procedures manufactured by a consultant are put in place. Between those two extremes, the most common approach to mixing these strategies is found.

Both strategies have their advantages and disadvantages. By establishing procedures within the company from scratch, the procedures have the potential to reflect the specific ship operation and to involve the people close to the operation in identifying the safety critical operations on board and describing how work is to be carried out. On the negative side, the quality of the content of the procedure might not be in compliance and the content might make sense only to those already familiar with the operation. Implementing procedures from external sources such as classification
societies or safety management consultants might guarantee a certain standard of the procedure as well as compliance, but might not fit the specific operation very well and therefore might favour generic key operations and not what is found essential in the specific ship operation.

Establishing procedures entails addressing difficult questions such as: Which operations need to be covered by a procedure? What is the purpose of the specific procedure? How extensive should the procedure be? At whom is the procedure directed? Which sub-documents are needed? These questions may seem easy to take into account, but in practice it turns out to be more complicated. The two case studies below exemplify a selection of different types of complications that address the questions above as well as how the documents are structured.

4.2.1 Case study: Procedure relating to mooring operations

The following procedural documents were collected in 2013 during an investigation of a mooring accident involving a chemical/product tanker. These documents relate to mooring operations and serve as an illustrative sample of procedures available for use in many shipping companies. It is an appropriate sample of procedures that would typically be found in most safety management systems.

The main document regarding mooring operations that was available to the ship’s crew was a manual that contained a section on safe mooring operations. In addition, a risk assessment was available. From the structure and content it appeared that these documents were part of the company safety management system, and that they were developed and maintained by the HSQE unit in the company. The content was based on the knowledge gained from experience within the company, industry guidelines, rules, maintenance standards, etc.

Specific quotes from these documents will be analysed to illustrate how the problems faced with establishing procedures were addressed by this particular company. Texts in italics are directly drawn from the documents. For confidentiality reasons, the actual document is not attached to this report.

The shipboard manual was a generic document and not specific to an individual vessel. The document was divided into three sections: 1) Scope, 2) Procedure and 3) Documentation.

Section 1, ‘Scope’, stated that:

“This procedure describes the standing orders and lines of directions for the Masters and their deck-, engine officers and -ratings in performing their duties when the vessel is about to commence mooring- or unmooring operations.”

This section was clear in its purpose and targeted end-users; it was the company’s standing order to all crewmembers involved in the operation, supervision and maintenance of mooring equipment and machinery.

Section 2, ‘Procedures’, covered a number of topics such as familiarisation, list of factors to consider, descriptions of equipment, advice on safe mooring and general safety reminders. The main part of this section consisted of detailed technical descriptions of mooring winches, wires, ropes, steel shackles, etc.
Interwoven in the technical description was text that could be interpreted as guidance, orders and description of duties. It is unclear to whom these instructions were directed. It would appear that some of these instructions were directed to the ship’s crew as a whole and others were directed to crew members with specific skills and competencies.

Throughout the procedures the text keeps shifting its purpose and intended user as is illustrative below:

“It must be ensured that the safe moorings of the vessel at all times must be able to resist the following factors: wind forces, current and tide conditions, surges from passing vessels, waves, swell and seiche, ice and changes in draft”.

A closer examination is required to establish the purpose of the text. It is not clear if the purpose of communication is to be taken as guidance or command. Presumably, crew members should be aware whether the mooring lines are able to withstand the varying forces of the environment such as weather, wind, sea state and tidal conditions. Therefore, the purpose of the text is not necessarily intended to raise awareness of the hazards associated with varying environmental conditions. Rather it appears that the purpose is to allocate responsibility. But if that is the case, the phrase ‘It must be ensured’ does not make it clear to whom the responsibility is allocated. Could it be to all crew members or to a specific crew member holding a specific job function? The question remains unanswered.

“The most serious danger is snap-back which means the sudden release of the static energy stored in the stretched synthetic line when it breaks and the crew must consequently stand well clear of the potential path of snap-back.”

The text provided information, presumably to the whole crew, about a particular risk (snap-back), which was controlled by a particular order (‘must’) that the crew should ‘stand well clear of the potential path of snap-back’. This particular procedural text highlights the difficulty in determining how extensive and detailed the procedures for mooring should be. It was considered crucial by the company that the risk of being struck by a broken mooring line was incorporated in the procedures, but the risk is dependent on a variety of factors, such as the type of rope and the stage of the mooring task. The end result was a text that included all scenarios: ‘potential path of snap-back’, which is basically everywhere.

Throughout the procedures, there are a number of messages that use normative language that implies a supposed a priori knowledge or a certain set of moral and professional standards without specifying where the crew members would gain such insight. Some examples of normative language with an unspecified purpose:

“At joining the vessel it should be obvious that officers and ratings who are about to use the vessel’s mooring equipment must make themselves familiar with its operation and capabilities”

The phrase ‘it should be obvious’ is also worth examining. If certain expectations are so obviously expected from all officers and ratings then what is the value in incorporating this statement in the procedures?

“A safe and excellent vessel mooring management requires a good knowledge of the mooring principles commonly used, careful planning, information about the mooring equipment installed on board, proper and correct maintenance of the equipment, and good, seamanlike line tending.”
The above text involves such extensive usage of normative language and subjective terms that it could mean different things to different people:

- ‘Safe and excellent mooring’, ‘good knowledge’, ‘mooring principles commonly used’, ‘careful planning’, ‘proper and correct maintenance’ and ‘good, seamanlike line tending’.

It is common in safety procedures to find conflicting messages, for example orders and guidance that are mutually exclusive. One example from the mooring procedure is a safety reminder that “[…] should be noted and adhered to by the crew”:

“Always stand well clear of a mooring wire under load.”

As a stand-alone statement this is a sound piece of advice that is difficult to ignore. But as a procedure for mooring operations, intended to assist a seafarer, it is somewhat misleading. It is simply not possible to perform ‘good, seamanlike line tending’ and ‘always stand well clear of a mooring line under load’, simultaneously.

Section 3, ‘Documentation’: In this section, there was an extensive list of reference documents on which the procedure was based. It also served as the basis for further recommended reading. But it was not clear how these documents could be accessed and who should read them. Although packed with an abundance of good information relevant to mooring operations, it was too extensive and non-specific for a seafarer to use it in practice. As an example it is unlikely, although not entirely, that a deck hand would review ‘Company Circular Letters’, STCW or SOLAS to gain knowledge about mooring operations.

4.2.2 Case study: Bridge checklist

The checklist below was collected during an accident investigation involving a small offshore supply ship. It is a representative of checklists used for navigation on ships by most companies. As such, it serves as an appropriate object for an analysis.

The “Bridge Checklist” also referred to as “Bridge arrival/departure checklist” was a sub-document related with two procedures in the ship’s ISM system: “Procedure for the start-up of bridge prior to departure” and “Procedure for readying the bridge prior to arrival/port”. Both procedures were situated in the ship’s ISM system’s section 7, “Shipboard Operation”, in the subsection “Arrival, departure and mooring procedures”. The procedures do not have a unique identification number, but they were stated as separate procedures within the subsection:

- **“Procedure for the start-up of bridge prior to departure”**
  The bridge is started up as set out in Bridge departure/arrival check list # 7-0204D, awaiting the ready message regarding passengers from deck.”

- **“Procedure for readying the bridge prior to arrival pilot/port”**
  Prior to arrival pilot/port the status is checked as set out in Bridge check list, check list # 7-0204D.”

It is stated in the ship’s ISM system that procedures comprise “how and when we do it and who does it” and that the checklists deal with “how do we know what who did and when it was done”. However, in the procedures above, it is not specified who the user of the procedure is, but the pro-
Procedures can be interpreted as directions from the back office to the bridge team. In the case of start-up of the bridge, the procedure requires the start-up to be carried out as described in the bridge checklist. The description of how the bridge is started is hence transported to the checklist which according to the ISM system should serve rather as a memo than as a work description.

The bridge checklist is seen below (figure 4).

![Bridge Checklist](image)

**Figure 4: Checklist requisitioned during an accident investigation**  
*Source: DMAIB*

Note that there are only two alternatives for completing the bridge checklist – a tick off or N/A (not applicable). The checklist consists of eight item categories. Certain items in the checklist contain an action verb which is affirmed by a tick off. However, it is not an option to comment or report negatively against any item. Furthermore, many items do not contain an action verb (for ex-
ample GPS, Log, NAVTEX), in which case the purpose of completing the check (either with a tick off or N/A) remains unclear. If the intention is to transfer the description of the task from a procedure to a checklist, the description of the task in the checklist is absent. The checklist does not offer much in the way of how to start up the bridge. Also, the bridge checklist does not make any reference to its parent reference procedure.

At the bottom of the checklist, a signature is required by the person completing the checklist. The purpose of the signature is two-fold: that the status of each item has been verified and that a responsible person has completed the checklist. It is not possible for a responsible person to sign the checklist without verifying the status of each item. But in doing so, the purpose of the checklist has changed from an extended description of a procedure to a document used for allocating responsibility.

Furthermore, the actual purpose of the checklist is not clear. If used as a procedure, it should serve as a work instruction and, if used as a checklist, it should serve as an aide-memoire. However neither of the two purposes is achieved. Rather the checklist is merely about recording and verifying the functional status of items.

A checklist such as this raises several questions. For instance does the tick off confirm that the instrumentation has been turned on or is it merely to prove that it is in working order? And why do the items need to be checked – to ensure that a specific task is carried out or merely for the sake of reporting (to the shore-based office) that the checks were actually carried out?

It may be that the checklist is meant to serve several multiple purposes – both as a work instruction and as a document for monitoring the conduct of seafarers on board. However, in fulfilling the multiple expectations, the checklist becomes underspecified in its purpose. This is problematic when the detailed work specification of procedures is transferred into checklists.

4.2.3 Procedural complications as symptom of systemic complexity

The case studies above show that procedures have limited space within which to unfold and continuously balance between being too simplified or too detailed and extensive. Furthermore, procedures often embrace several purposes simultaneously, and in these cases it tends to be unclear to the user what these purposes are and to whom they are directed. When the procedures encompass multiple purposes that are not compatible simultaneously, the procedure tends to become opaque and difficult to put in to practical use, especially when this extends to the majority of the documents.

Procedures prove not to be a consistent phenomenon in practice, but range from abstract and absolute commands addressing the moral and competence of the seafarer to an optional guideline. Hence, the phrase of “the accident happened due to a deviation from the procedure” is not universally a solid conclusion, because the prescriptive meaning of the procedure is in practice heterogeneous.

When procedures drift into ambiguity, it does not necessarily point to a lack of competence in writing procedures. Instead, it can be perceived as a symptom that points to systemic complexity. An embryo of this systemic complexity can already be traced in the ISM Code, which serves as the DNA of the safety management system. This will be unfolded in the following section.
4.3 The complexity of multiple goals in Safety Management Systems

In the maritime sector, safety is often treated as a stand-alone, isolated goal by many companies. This is evident in designing and adopting a ‘safety management system’ that is concerned only with safety, whilst leaving aside the multiple activities and goals of the companies. And here too, safety is ensured by means of compliance and allocation of responsibility. However, compliance and responsibility are not limited to safety risks alone. Their application can be felt in mitigating wider risks beyond safety risks and this can create goal conflicts in managing safety.

4.3.1 Compliance

A key purpose of the ISM Code was a movement from a prescriptive regulatory framework established by the authorities and other external bodies to the implementation of an idea of regulated self-regulation. However, the Code still emphasises the importance of compliance. It is mandatory to be in compliance with the ISM Code in order to operate ships in international trade. This means that the ISM Code couples compliance and economic risk in order to facilitate the safe operation of ships. In theory and in the Code, this coupling seems to be simple. However, in practice the coupling of compliance and economic risk becomes complex in the safety management system due to the influence of other stakeholders.

Charterers may have to meet certain legal and contractual requirements made by the shipping company. As a result of this, charterers may require a new set of procedures to be added to the safety management system. Over a period of time, this can add to the size and bulk of a safety management system. And since such documents were implemented for economic and legal reasons, their existence and application may not always make sense to a seafarer or might not fit the ship’s operation. This is the paradox of self-regulation. A safety management system designed to move away from prescriptive regulations towards purposeful and goal based regulation eventually falls victim to its original intentions.

Charterers can require the company to provide extensive documentation for the safe operation of the ship. The documentation required is that of the safety management system. The number and type of non-conformities then become not only data for improvement of the system, but also a key performance indicator and sales parameter. The documentation then serves at least two incompatible purposes: one seeking to bring forth areas in need of improvement, while the other one is seeking to lower the number and severity in order to mitigate the economic risk of losing customers.

There is an embedded thinking in the ISM Code that compliance and safety go hand in hand. Compliance ensures a certain safety standard. Instead of relieving the prescriptive regulation laid down by external bodies, the move to regulated self-regulation by the companies has, by means of the documentation requirement integrated in the Code, resulted in an increased number of prescriptions laid down by market terms. The documentation provided by the safety management Code has become an expression of safety both in terms of avoiding accidents, but also safety in accordance with business and liability concerns. This means that safety and economic risk are being handled at the same time and often mixed up. A low number of reported incidents or non-conformities do not necessarily reflect a high safety level – it might as well reflect the market terms where safety has become a commodity.
4.3.2 Responsibility

The master is ultimately responsible for managing the safety of the vessel, but the ISM Code acknowledges that the master alone cannot fulfil this responsibility. A designated person is appointed to provide a link between the ship and the company. In addition, the responsibility and authority is spread evenly through the organisation.

But allocating responsibility can be problematic when the end goal is to manage safety risks. An undesirable outcome (accident, incident, etc.) may undermine both the safety and economic survival of a company, thus implicating those responsible for the design, functioning and maintenance of the safety management system. And this would generally be those employed in shore-based offices. Hence, shore-based offices have to manage not only safety risks but also the risk of being held responsible.

The role of procedures is worth examining here. When procedures shift from being specific to generalised and outcome-focused, it makes space for discretion and autonomy for the end-user (in this case, the seafarer). The role of the shore-based office is to provide support functions, while the seafarer is left to manage the conflicting goals of the safety management system (economic and safety risks). It is here that the space for discretion in the procedure acts as a buffer to protect the image of the shore-based office. If the outcome turns out to be unpleasant, it is the seafarer who should have made a better judgment in this discretionary space. Although a key purpose of the ISM Code is to ensure that the responsibility for safety management is evenly distributed between the ship and the company, undesirable outcomes are often projected as instances where procedures are not followed by the seafarer.

4.3.3 Management of different types of risk

The safety management system manages different types of risk and safety that are not directly linked to preventing accidents. The safety management system also mitigates economic risk and the risk of being held responsible, at the personal or organisational level. That the safety management system covers several areas of concern and is not limited to safety matters alone is natural, because safety does not exist independently from the companies’ other activities. It is, however, necessary to be aware that the safety management system handles several risks that can be in conflict and that risks need to be distinguished from each other.
5. WORK AS IMAGINED & WORK AS DONE

In this section, the notion ‘procedure’ will be used as an umbrella term covering both emergency procedures, procedures connected to operation, and documents subordinate to the procedure, e.g. checklists and instructions.

5.1 Procedures in an operational context

According to the ISM Code, procedures should be established where safety critical operations are identified. The purpose of these procedures is to guide the operator through a given task and to act in a formalised manner that is considered safe. The procedure ensures safe operation by describing the task and puts several sub-documents in place that instruct the user how to complete a given task correctly. Procedures create safety by outlining a path of safe behaviour and staying on this path constitutes an immaterial barrier against unwanted outcomes. In reverse logic, stepping aside the procedure can cause an accident, and this logic is well-known and used in practice without causing controversy. Deviating from procedures is frequently stated as the cause of an accident or a significant contributing factor – either directly or by referring to ‘human error’. But if procedures ensure safe operation, why do people deviate from them?

Over the years, the DMAIB has found it fruitful to answer this question by taking a closer look at the nature of the procedure and at the context in which it is used. A procedure is a standardised description of a given task and is in essence static in its form as a document. Procedures and safety management systems can be and are, according to the ISM Code, supposed to be living documents that are continuously revised. However, in-between the revisions, the documents rest in a valid form, and they describe one generic situation. When such a document is put into use in an operational context characterised by a large number of dynamic and varying factors, a number of fundamental problems can be observed to arise from the discrepancy between the procedure and the operational context it is describing; there is a difference between work as imagined in the procedure and work as carried out.

The following sub-sections will provide the five most significant discrepancies in procedures as investigated by the DMAIB.

5.1.1 Ellipsis

Procedures for safety critical activities are typically established on the basis of an individual or an organisational idea of how a given task is to be carried out and what risks are associated with that task. In the process of creating an optimal work procedure, some elements of work are omitted and some are chosen to be relevant, because the procedures are established by an individual or group idea of how work is to be carried out. In the procedure design process, some ideas of risk will be added and some ideas of risk will be omitted, which can result in procedures missing important perspectives of risk. Furthermore, the process of establishing procedures also relies on pre-existing categories of work and risk, e.g. enclosed space or work aloft, which may be problematic when the seaman is carrying out tasks that contain work of many different categories. This problem can be illustrated by the following example: The DMAIB investigated an accident on a tanker where a crewmember was killed from falling from the ladder/stairs when entering a cargo tank for inspection (figure 5).
The procedure for cleaning cargo tanks on this particular tanker referred to documents that were designed to mitigate the risks with working in enclosed spaces – specifically the risk related to the presence of toxic vapours and lack of oxygen. The risk of working aloft was omitted during the design of the procedure for tank cleaning, because that category of risk was connected to other types of work tasks, which were related and isolated to e.g. climbing up masts.

5.1.2 Variability

A written procedure within the safety managements system is, at any given moment, a static description of a standard task, e.g. procedure for mooring operation. However, some situations require adaptation by the seaman in order to meet changing operational circumstances that are not described in the procedure, e.g. the berth is not designed for the mandatory mooring configuration described in the shipboard procedure. In changing circumstances, it becomes necessary for the seaman to negotiate the content of the procedure with the situational context, which brings the seaman to be non-compliant with the procedure. Whether or not non-compliance is an acceptable part of the everyday work depends on the outcome of the work.
5.1.3 Hierarchy of knowledge

In order for the seaman to understand and correctly apply a given procedure, he has to have knowledge about why a given procedure is designed the way it is, because he will be required to fill in the gap between the static nature of the procedural text and the dynamic operational circumstances. The seaman must, from the language in the procedure, gain an understanding of the procedural boundary of knowledge from where he can step in and act independently. Some procedures acknowledge that everyday work contains a variability which cannot be described in a static document. In these procedures the daily variability is met by using phrases as ‘according to good seamanship’ or ‘as deemed necessary’. The purpose of these phrases is to give the seaman a discretionary space where the seaman can apply his/her own judgement. Thereby, the phrase ‘good seamanship’ directs the seaman to analyse a given work situation and to act accordingly. Whether or not the seaman’s analysis of the situation was adequate would likely be judged on the basis of the outcome. This raises a question about the hierarchy of knowledge between the procedure and the seaman.

An example of the distribution of knowledge between the procedure and the seaman can be seen in the picture of an aft mooring station as shown below (figure 6).

![Figure 6: Mooring deck on a container ship](Source: DMAIB)

The picture above shows two mooring ropes under tension. The yellow paint indicates that a potential hazard is present (it is uncertain if all the yellow paint is related to mooring). The company’s mooring procedure contains knowledge of what the hazard specifically consists of (wires and mooring ropes under tension) and it describes that mooring snap-back zones are to be avoided while the mooring ropes are under tension. It is not described in the procedure under which circumstances the snap-back zones are relevant, i.e. is the risk the same irrespective of where the rope breaks? Is the deck area safe outside the yellow zones? These questions can only be answered by the seaman who is expected to have knowledge about the risks present in the different stages of the
mooring operations. Safety during the mooring operation is dependent on the seaman’s perception and assessment.

5.1.4 Practical and cognitive circumstances of use

The DMAIB often see emergency procedures that are not designed to be used in adverse environments, and which do not take consideration of the cognitive pressure the seaman is exposed to. This has specifically been observed in emergency situations where all crewmembers were directly involved in fighting a rapidly developing fire. There were problems with the practical aspects of how to gain access to the procedure if it was electronic and there was a blackout, or how to read the paper procedure on open deck at night with gale force winds. Furthermore, the stressful situation limited the cognitive capabilities of the seaman to such an extent that the procedure became useless, because it required the seamen to carry out analytical tasks or perform judgements that they were not capable of in that situation.

5.1.5 Reliability of procedures

The procedures established to encourage safety during operations are often based on the premise that the ship is a reliable system that would function optimally and in accordance with the design intent. But this is far from true when almost all subsystems (e.g. navigational systems, propulsion systems, fire-fighting systems, mooring systems, etc.) are constantly interacting with a harsh working environment and are subjected to wear and tear. But the procedures rarely take account of the shortcomings and underperformance of machinery and equipment. Often, these difficulties are overcome through the initiatives of seafarers which include negotiation, improvisation and trade-offs. A failure of a mooring winch during harbour stations can be compensated for by making use of rope stoppers and switching to alternative winches. Similarly the risks arising from underperforming radar can be filled through ‘soft measures’ such as frequent position plotting or enhanced lookout. Procedures are modified to address the operational challenges. This highlights another paradox of procedures: procedures ensure safety by capturing formal knowledge about operations. But this formal knowledge can become less effective when faced with an uncertain situation. Faced with unexpected breakdowns and malfunctioning of critical machinery, not following the procedure may be a safer choice for the seafarer.

5.2 Deviation from procedure?

The discrepancies between procedures and the operational context, which they refer to, show that procedures within the safety management system are not complete. The gap between the operational situation and the procedure is bridged by the user of the procedure, i.e. the crew on board. Because procedures are in essence static, but are used in an operational situation characterised by a high degree of variability, procedures can be resembled to semi-manufactured goods that are completed by the end-user on site. Viewed this way, not following procedures closely or even deviating from them can be a sign of the crew’s adaptability to a given situation. Procedures cannot describe all possible situations; therefore, following procedures strictly could lead to accidents and make most ship operations impossible to carry out.

Deviating from procedures due to adaption to the operational situation happens continuously and is a normal part of the daily work that is not controversial. However, when an accident occurs, the discrepancy between the work as described and the work carried out in a given situation will be viewed as an anomaly in the process of causation analysis.
In the wake of an accident, deviation from procedure becomes visible and gains significance, because behaviour and decision-making prior to and during an accident are evaluated by comparing it to the standard described in the procedure. In this situation, procedure is used as a key to establishing what actions and decisions were right and wrong from a hindsight view. Procedure then changes from being a guideline to becoming a normative rule that has been broken: “the crew should have acted this way, but they did not.”

As the deviation from procedure changes in perception from being a part of normal work to being viewed as a cause of accident, and the procedure changes in function from being a general work description to being a normative standard, it is rarely questioned, investigated or understood from the user's perspective why the procedures were not followed. Because deviation in connection with an accident is regarded as trespass of a normative standard, the motives for deviating will already be limited to a negative frame of interpretation, and the seafarer is considered as an unreliable witness. Hence, those evaluating the behaviour will, due to the negative interpretation options, presume that the motives are mainly limited to either having to do with a lack of moral or a lack of competence.

Deviation from procedure is inevitable due to the discrepancy between the static nature of procedure and dynamic nature of operation. It is a part of normal work, but only becomes visible during an unwanted outcome. An accident can then be regarded as a window of opportunity to gain a privileged insight and understanding of the conflicts that the crew handles on a daily basis. Using procedure as a standard for evaluating behaviour and decision-making blocks this window of opportunity and hinders new safety learning.

6. RISK MANAGEMENT

Safety procedures are established in order to mitigate the risk of injuries and damage. In order to write these procedures, it is necessary to establish what the risks are. Safety procedures and the general risk assessment are carried out at both a back-office and ship management level. A risk picture can be formed in different ways, but mainly it consists in pre-existing thinking of risks connected to standard operations that are general across the maritime business as well as a risk perception based on previous accidents in the company, on the ship or in a particular shipping segment. The typical perception of risk is thus built on the principles of probability based upon data of previous incidents. In other words, the past serves as prognosis data for future accidents. Near miss reporting, which is an integral part of the ISM Code, is an example of this way of perceiving risk: by treating near miss incidents, future accidents can be avoided. Near miss reporting and a safety procedure established to function as a barrier against a calculated risk thereby reflect a perception of safety as absence of accidents.

Risk assessment and management often bears reference to the discipline of physics and mathematics as something that has to do with energy and force and which has a probability that can be calculated. This way of thinking is often represented by a risk management tool from which risk can be indexed, for example the risk matrix below (figure 7).
However, in an operational environment risk is not a mathematic value; it is a highly fluctuating and fluid concept. The perception of the risk connected to the same operation will vary according to who defines and perceives the risk and where this person is situated in relation to the operation. Therefore, back-office personnel and the ship’s crew will have a different perception of what constitutes risk.

As described in sections 4 and 5, it is not possible to construct a procedure that covers all variations of operational situations. Therefore, procedures describe a standard situation and the general idea of how work is to be carried out, as it is imagined by the back-office personnel who create many of the procedures, often with their own seagoing experience in mind. The risk mitigated by the procedures will likewise be defined as what seems most likely to occur in connection with the idea of a standard situation based on previous experience and a probability assessment.

Indexing risk with the purpose of reducing occurrences to a minimum in order to meet the zero accident criteria for safety that is supported by the market evaluation of companies can all together be regarded as an expression of a **bottom line safety perception**. Within the bottom line safety perception, the risk assessment based on probability serves as a prognosis for future accident occurrences, and a number, value or index indicates the nature of an operation or a company’s safety level at a general level.

Back-office personnel deal with a management system that apparently serves the sole purpose of managing safety, but market interest in numeric values symbolising safety means that safety is not an isolated matter and that risk comprises both accidents and the risk of losing customers. A probability-driven risk perception and a bottom line safety perception hence serve as a solution that deals with risk at a general system level at a distance from the actual operation and to satisfy customer requirements in order to stay in business.

![Figure 7: Example of risk management tool](source: DMAIB)
Seafarers on board the ships are in direct proximity to the elements that can inflict an accident. To them, the notions of risk and safety are constructed by the necessity to travel by sea. Safety is therefore not an isolated goal, and handling risk is integrated in the ongoing activities on board, as are several other needs that the crew are pragmatically seeking to meet in order to fulfil the success criteria.

At the seaman’s level, safety is created through a continuous assessment of the environmental circumstances that the ship finds itself subject to, and through the responses that the operator initiates in order to mitigate perceived risks. This process of assessment, response and mitigation is continuously ongoing when a ship is in operation, and it cannot be separated or extracted from other aspects of ship operation. Handling risks on board rarely depends on a formalised set of safety measures, e.g. procedures and documentation, and creating safety at the crew’s level often means a trade-off between a large number of conflicts, e.g. bending procedures in order to get the work done.

A risk perception-based probability calculation and previous accident procedures do not necessarily provide a good view of any imminent dangers. Though accidents may seem alike, they very often have significant differences making them unique, and the sequence of events most often seems unlikely at first hand. This means that what happened in one accident will most likely not happen in the same way again. Therefore, the perception of risk as calculable and predictable can be inconvenient. A generic probability calculation of risk in connection with a specific type of operation that has become a standard might even impose a risk itself – by highlighting an imagined risk it might lead to blindness of the immediate elements of danger that might vary, that might be unlikely or that cannot be imagined by the one making the generic risk assessment, who is often the manager placed at a distance from the daily operation.

Procedure as a safety barrier is an immaterial barrier. This type of barrier can be implemented very fast and does not require a great amount of resources in terms of personnel and costs. This means that procedures work well as a speedy response to mitigating a detected risk. When a risk has been mitigated by any kind of barrier, the risk is indexed to a lower risk level. An extreme risk can, by means of procedure implementation, be downgraded to a low or medium risk. However, the procedures do not remove the present dangers connected to a certain work place or operation.
7. PROCEDURES AND SAFETY CULTURE

The ISM Code, section 1.2.3.1, states that the objective of the Code is to ensure “compliance with mandatory rules and regulations”. Furthermore, the introduction to the guidelines for implementation of the ISM Code states that: “The application of the ISM Code should support and encourage the development of a safety culture in shipping. Success factors for the development of a safety culture are, inter alia, commitment, values and beliefs”.

The text states that safety culture is something that can be developed through the application of the ISM Code. In practice, this is achieved through the instruments of the Code, i.e. procedures, policies and checklists. Compliance is understood as the basis for “safety culture”. It follows that ensuring a high level of compliance becomes the main aim of developing a safety culture. This is a functionalistic approach which implies that safety culture is something that the company is in possession of or something which can be designed and put in place. In this functionalistic approach, safety culture can be measured and even modified to support the desired goals such as those stated in the ISM Code objectives. The objectives of the organisation then become:

- To influence the behaviour of individuals working in the organisation, by internalising safety as a value and belief, as a sort of moral conduct for determining right and wrong to believe in and follow. The policies are instrumental in this respect.
- To continuously guide the behaviour of the individuals working in the organisation, including a definition of their freedom and constraints. The procedures become influential here.
- To regularly monitor the performance of individuals and groups within the organisation to assess their level of compliance, and to determine the need for corrective action either of workers or the system (often by tightening the constraints). Auditing of individuals’ attitudes, knowledge and safety management documentation, including checklists and procedures, is the primary tool offered by the ISM Code.

In all the objectives above, the underlying assumption is that seafarers must be guided and controlled, and that the systems per se are functioning well (as designed, and described in the SMS). Failure to comply becomes the expression of a moral defect; a violation of normative rules and this goes against the objectives of the system (including ISM objectives). Everyone is responsible for achieving these objectives and it is as if the objectives on their own will lead to a successful outcome. Hence, the obvious conclusion following an unsuccessful outcome is the failure of the individuals to comply with the objectives. But rarely do we question the structural elements of the system, the procedures and the checklists, their quality, suitability and relevance in daily work. The explanation for an unsuccessful outcome often rests with the amoral individuals or with specific entities within the organisation who may have failed to comply with the safety management system.
8. PROCEDURE AS SAFETY MEASURE

When deviation from procedure is identified as the ‘cause’ of an accident, the underlying assumption is that procedures would have prevented the accident if only they were followed. Procedures become safety measures that can be put into effect. In the previous sections, we have identified certain characteristics and limitations of procedures as safety barriers. These can be summarised as:

Advantages
- Rapid implementation and less resource intensive than introducing hardware.
- Fit into the functionalistic perception of safety culture.
- Provide a feeling of security and signal improvement.

Problems
- Procedures are static and rely on the status of functional and operational systems on board.
- The physical and cognitive accessibility of procedures by the end-users is critical.
- The effectiveness of procedures as safety barriers is difficult to evaluate.

Consequences
- Procedures as safety barriers have a moral implication that incriminates human behaviour.
- The net effect of procedures could be overstated in terms of providing support to the seafarer in a dynamic and uncertain work environment.

Safety procedures might be effective in some situations and for some tasks when they are allowed to be short, very specific and a tool for remembering what to do in which sequence and by whom. However, as the DMAIB’s investigation shows in sections 4 and 5, safety procedures cannot describe all situations and, additionally, the safety procedure deals with various kinds of risk at the same time. This often causes the procedures to be either over- or underspecified and very unclear in communicating their purpose. Furthermore, the procedures as barriers are likely to be put in place where they are not effective because they are easy to implement. In order for safety procedures to be effective, it is necessary to take a new and critical look at how they are created and for what purpose and to be aware of the functional limits of procedures.
9. CONCLUSION

Starting from the assumption that procedures act as safety barriers, we can easily get framed into the discourse that not following procedures leads to an undesirable outcome. From here onwards, the managerial initiative is focused on controlling the behaviour of workers in ensuring that procedures are followed. It is not surprising that every undesirable outcome is met with even more procedures and checklists to the detriment of the safety management system as well as the safety culture.

However, deviation from procedure is inevitable due to the discrepancy between the static nature of procedure and the dynamic nature of operation. It is a part of normal work, but it only becomes visible in the aftermath of an unwanted outcome with hindsight. An accident can then be regarded as a window of opportunity to gain a privileged insight and understanding of the conflicts that the crew handles on a daily basis. Using procedure as a standard for evaluating behaviour and decision-making blocks this window of opportunity and hinders new safety learning.

Safety management systems have expanded to include more than just safety risks. The management of safety now includes the economics, marketability, liability and reputational risks of the organisations. This can easily result in defensive reporting and record keeping techniques and demonstrating ‘safety on paper’ purely for compliance purposes. All this may take us away from the core objectives of safety management systems.

Instead of thinking procedure as a safety barrier (with its moral implications, ideas of standardisation as a way of creating safety, and frailty due to the need for systemic and human reliability), it could be of advantage to look at procedure in a different light: procedure as an aid or guidance. Safety procedures should be acknowledged as bureaucratic tools that do not create safety by their mere existence. Procedures manage risk, but do not necessarily create safety. They can, however, lay out instructions, authority, and responsibility for personnel in both management and operational situations. The crux of the matter, though, is to at least be aware of the different purposes of these procedures, to make them clear, and to distinguish between different types of risk.