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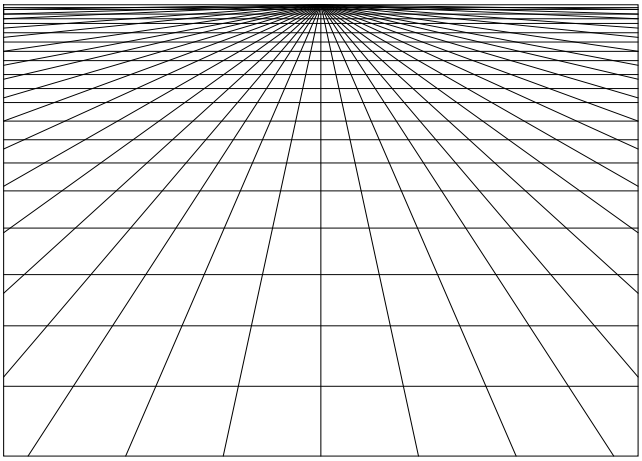

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Risk Assessment in the Shipping Industry
An analysis of Standardized Approaches

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2009

Word count: 19854

Acknowledgements

I would not have been able to complete this thesis had it not been for valuable help from certain key persons. I would like to thank my supervisor Ragna Zeiss at Maastricht University. I would also thank friends and family for support throughout the thesis period. I will always be thankful that the shipping company allowed me to travel with one of their ships.

Last but not least, I would like to thank the crew members on board the oil product tanker I travelled with. You guys gave me an experience I will never forget.

However, only I am responsible for the content of this thesis and all potential errors are mine, and mine alone

Egil Heinert (sign.)

Oslo, 2nd October 2009

Abstract

The shipping industry is according to the International Maritime Organization the most international of all industries – and one of the most dangerous (IMO 2002 [url]). Since the first oversea commercial transactions, dated as far back as to 3000 BC, the industry has been a key in the world wide transportation network (Hänninen 2008).

Being an international and dangerous industry, the industry has together with the maritime world realized the need for general rules and regulations. One of these regulations is the requirement of having a standard system for ensuring safety on board ships.

This system, in this thesis known as the Safety Management System (SMS), is developed by the shipping companies in co-operation with classification companies. The shipping company is responsible for the implementation of the SMS, while the classification company is responsible for controlling that the actual work practices comply with the written procedures. However, both the implementation and the controlling of the SMS have proved to be a challenge. I have yet to find literature that explains these challenges. This thesis will in this respect try to give an indication to possible theories on why the SMS does not work as intended on board ships.

Research on approaches to risk has shown that lay people have a different approach to risk than "experts". Research on standardization has shown that when standard procedures are not seen as meaningful, it is less likely that the procedure will be implemented as intended. Based on a case study where I spent one week on board an oil product tanker, I will use these theories as a framework for explaining reasons to why the Safety Management System is not implemented as intended on board ships.

Key words: Shipping, Approaches to risk, Standardization, Manuals, Risk Assessment

Risk Assessment in the Shipping Industry
An analysis of Standardized Approaches

(Photo by Egil Heinert 2009)

1.0 Introduction

On the 18th August 2008, an accident occurred on board the Norwegian open hatch bulk carrier M/S Star Java. While working on a loading operation with one of the ship's cranes one of the boatswains got crushed. The boatswain tragically lost his life (Accident Investigation Board Norway).

The report after the accident revealed a number of areas where tasks had not been done according to procedures. First of all, the chosen practice for work with the crane was not the same as specified in the crane's manual. The reason for this was according to the Accident Investigation Board that the crane design had been developed gradually over a long period of time and that many of the crew members had lengthy experiences including serving with ships that had open cranes. Also the fact that there had been no serious accidents with the crane in the past was pointed out as important. The shipping company's Safety Management System (SMS) was not able to identify the non-conformity between operating procedures and work practices for securing the crane. The report also states that the company should have conducted a risk assessment and implemented safety measures based on the assessment.

Besides that there had never been a major accident with the cranes, the report says little about why there was not conformity between the operating procedures and actual work practice. The report does not say why the SMS was not able to identify this non-conformity. This thesis will try to give an explanation to these questions.

In order to research this, I decided to spend just under one week on board an oil product tanker, hereafter known as "the ship". The reason why it was this particular ship is that I had a contact person on board, who was able to help me get a free pass agreement. Even though the

ship was not the same as the M/S Star Java, the standardized SMS is similar on the two ships because they were both classified by the same company. I will argue why the findings and conclusions in this thesis could to some extent be transferred to this case as a comparable unit.

Research on standardization has indicated that for a standard to work as intended, workers need to find the standard meaningful. If not, the standards written procedures, seemingly based on an objective truth, are not likely to match the daily work practice. Research on risk has shown that lay people have another way of approaching risk than "experts" on the specific area. This thesis will therefore discuss the question:

How do different approaches to risk in the shipping industry affect how the Safety Management System is dealt with in practice on board ships?

Another theory of why the crew members on the M/S Star Java did not follow the SMS' written procedures could have been that they did not regard the operation as risky. As already mentioned, research on standardization suggest that a standard has to be meaningful for the workers to be incorporated into their work practices, and could be an explanation of why the SMS was not implemented. This thesis will therefore explore the possibility of a lack of correlation between what the SMS and the crew members regard as critical operations could be a reason the SMS is not implemented as intended.

1.1 Chapter overview

Chapter two will first give an account of two of the approaches to risk, the technical and the economic. I will explain how the technical and the economic approach can function through

the development of standards and audits. I will also give examples on research that are conducted on these areas. I will thereafter give an account of the constructivist approach to risk, and highlight some key elements of what characterize lay people's approach of risk. I will also give an account of Brian Wynne's research on Cumbrian sheep farmers, to exemplify how cultural values and background influence people when making risk decisions.

Chapter three will describe the process I had for getting on board the ship. I will discuss the negotiations between myself and the head office, and explain the advantages and disadvantages this gave me when collecting empirical research. I will also discuss my first meeting with the SMS, when I had to take part of a safety course on board. The ship and its crew will also be accounted for in this chapter

The fourth chapter will give an account of some of the key conventions that are influencing the development of the SMS to give an indication of the complexity of the manuals. I will explain what the SMS regarded as critical operations and compare this with what I found through interviews what the crew members regarded as critical.

Chapter five will give a description on how what the SMS regarded as the correct way of assessing risk through the "take 5", the "Tool Box Talk" and the SJA/RA and explain how the economic approach to risk is visualized through these manuals. I will discuss how they can be said to reflect different risk approaches and I will discuss how these standardized risk assessment tools assessment worked in practice on board the ship and how

Chapter six will give an account of an incident six months prior to my trip concerning one of the ship's two boilers. The incident will be an example of the limitations of the technical risk approach, and I will try to explain how evidence can be said to be socially constructed. In the report after the MS Star Java accident, one of the conclusions was that an audit will not necessarily identify non-conformities between an established procedure and actual work

practice. The aftermaths of the boiler incident is good example on the limitations of audits, and I will explain why audits not always are able to reveal non-conformities with procedures and actual work practice.

Chapter seven will sum up the general findings in the thesis. I will also try to point out some general challenges when doing risk assessment, and also other areas in the shipping industry where more research could be interesting.

1.2 Methodology

Methodology will be introduced in the third chapter, and also discussed in other chapters as well. For now, I will only emphasize that the observations described in this thesis were written down in my notebook. This includes the conversations I had with my contact person and the head office prior to my trip, and the observations I had on board the ship. A rule on good field notes is to write them no less than the morning after the observation (Gilbert 2008: 274), and in general I was able to do that. These notes are together with the SMS manuals the main sources in this thesis.

1.3 Limitations and scope

Much attention in this thesis will be given to the SMS manuals. A thorough analysis on how these manuals are produced will not be a part of this thesis. I will only state that that all documents are socially produced (Gilbert 2008: 287), which includes the manuals I will describe. I will however give a short description on which conventions the manuals are developed from, to give an indication of the complexity of regulations in the industry.

This thesis will focus on risk concerning humans. This does not that there are other possible risk in the shipping industry. Oil spill and pollution are two areas of great concern for many people, and where also described in the SMS manuals, but will with the limitation of this thesis not be included. Risk related to property can said to be mentioned to some extent, because human risk situations are often related to damaged property. Nevertheless, the main focus will as explained be the ones related to humans.

With this thesis I hope I will contribute to a better understanding on the approach to risk on board ships. To my knowledge, there is little research done on this particularly area, and the thesis could be a start of further research. I will also try to point out other areas that are not thoroughly discussed in this thesis, which would be interesting for further investigation. I hope also that the thesis will be a contribution to better the understanding of the shipping industry, an industry highly international and complex.

2.0 Approaches to risk

In our daily language, risk is often associated with fear of hazard, gain or loss and uncertainty (Jaeger 2006: 16). Definitions on risk vary from risk being the result of a threat with adverse effects to a vulnerable system (Haimes 2006: 293), a situation or event in which something of human value has been put at stake and where the outcome is uncertain (Jaeger 2006: 17) to constructivists who claim that risk is merely perceptions (Shrader-Frechette 1991: 31). In this thesis, I will separate the sides in the risk debate in two groups, the positivist and the constructivist side. Under follows a description of the three approaches to risk mentioned in the introduction, the technical and the economic approach which I will argue is a sub group of the positivist side, and the constructivist approach. These approaches are important to understand, as I later will show that they are all to be found on board the ship. I will also give examples on how the different approaches work in practice, drawing examples from theory of

standardization, audits and lay knowledge expertise. I will explain weaknesses as well as strengths to the approaches to give a theoretical background for my findings on board the ship.

2.1 The positivist side

Positivist has adopted what Shrader-Frechette (1991: 39) calls "principle of complete neutrality" in their approach to risk. This means that it is possible to exclude normative components when doing risk estimates. Hazard assessment can thus be value free and applied ethics and methodological criticism is advocacy for subjectivism. The main argument is, because risk is objective, that it is possible to do objective risk assessment, and is a fundament in both the technical and the economic approach.

2.2 The technical approach to risk

One of the subgroups to the positivist side is those who support the technical approach. The technical approach characterizes risk as an undesirable event confined to physical harm to humans and systems. (Renn 2008: 13). The idea is that with the help of enough statistical data, one is able to mathematically predict how severe and how often an undesirable event will happen, which will be the expected value. Haines exemplifies this when discussing risk after the 9/11 attack on World Trade Center. He argues that *Vulnerability* is the manifestation of the inherent states of the system that can be exploited to adverse effects. *Threat* is the intent and capability to adversely affect the system by adversely changing its states and *Risk* is the result of a threat with adverse effects to a vulnerable system. When doing risk assessment one is to (1) assess the likelihood of the threat (2) model the responses of the various interdependent state variables that characterize the system and (3) assess the severities of consequences resulting from the dysfunctional parts in system as a whole (Haimes 2006:

293). When all these areas are taken into consideration, one is able to calculate mathematically the chances and the outcome of an event.

The technical approach has been criticized for the complications that can arise when people face technological risks. When there is absence of sufficient data, experts often use models as tools to predict the probability of failures (Renn 2008: 16). These models are attempts to try to explain cause relationships between different parts in, often, complex systems. Probabilistic risk assessment is used in attempt to predict the probability of safety failures in such complex systems. Modeling of failures has proven to be difficult. Common mode failures (simultaneous breakdowns in systems) and human-machine relationship (for example lack of safety culture) are difficult to predict. This can lead the risk assessors omitting important pathways to disaster (Slovic 2000: 152), and is therefore problematic.

2.3 The economic approach to risk

Another subgroup to the positivist side is the economic approach to risk. As the technical approach to risk, the economic approach also claims that risk is something objective and measureable. The difference lies in that where the technical approach focuses merely on adverse effects, the economic approach takes positive gains into consideration when measuring risk. The economic perspective builds on the technical approach, but also takes into consideration the subjective satisfaction with the potential of consequences rather than a predefined list of undesirable effects

According to Renn the economic perspective to risk can be described as the transformation of physical harm or undesired effects into “utilities”, where utility describes the potential negative or positive outcome for a particular event (Renn 2008: 17-18). The economic perspective builds on the technical approach, but also takes into consideration the subjective

satisfaction with the potential of consequences rather than a predefined list of undesirable effects. By using utilities, one is able to take positive effects into account when measuring risks.

There are two areas where agitators have argued the economic approach is valuable (1) because subjective satisfaction can be measured for all types of consequences and (2) because it allows a direct comparison between risks and opportunities across different options. How safe is safe enough can thus be answered through this perspective. A risk is acceptable if the corresponding benefit provides more utility than the risk detracts from the utility (Renn 2008: 18).

In addition to the critique on the technical approach, the economic approach has been criticized for the difficulties of choosing the correct discount effect. Risks and benefits do not often materialize until several years after implementation (Renn 2008: 18), and therefore choosing the right discount is difficult. Another critique is an ethical question: is loss of, or harm to, a life possible to give a particularly risk rate? Many will claim that it is impossible to compare a human life with monetary units. I will return to these questions later.

2.4 Standards

In Frederic Taylor's "Scientific management", there is a close connection between development of standard procedures and science. Standardization is found almost everywhere in our society, from uniforms to other requirements. "*The notion was that predictability, accountability and objectivity will follow uniformity* and *as a process of emphasizing technological standardization and eliminating other established or culture-based standards"* (Timmermans and Berg 2003: 8).

The shipping industry is not a stranger to standards. Statutory regulations, classification society rules, international agreements and national specifications are part of the variety of rules and regulations the industry has to follow. Systems for assuring that a ship is following all mandatory regulation are developed by classification companies in co-operation with each specific shipping company. A classification company is a non-governmental organization. Its role in the shipping industry is to develop standards (classification rules) and to verify and document compliance with these. All commercial ships are required to be certified by a classification company to be allowed to operate. One part of classification is the requirement for each ship to have a safety management system (SMS). The accident report after the M/S Star Java accident gives a lot of attention to the company's SMS, as it is regarded as a key to assessing and limiting risks. The SMS is not specific teach ship. A shipping company has normally only one SMS which is valid on board all the company's ships. The owner company of M/S Star Java uses the same classification company as the one in my case. This is not as by any means a coincident as they both are Norwegian ships, and the Norwegian classification company, DNV, is one of the biggest classification companies in the world, offering classification services to many Norwegian ships.

Standardization is case specific (Timmermans and Berg 2003: 79), but some general findings are to be found about how standards actually work. In their research about the implementation on two protocols in the Dutch health system, Timmermans and Berg show that standardized manuals can work well for the workers as long as they are seen as relevant. The health workers they followed thought the standards could be helpful as long as they thought they were meaningful. If they did not, the standards were likely not to match their daily work practices (Timmermans and Berg 2003: 70). The guidelines were not a goal in itself for the health workers, but more like a structuring of what they had to do. The research showed that the health workers adapted the health protocols, and used it as a framework for their work.

Timmermans and Berg also showed that working with the guidelines requires proficiency rather than being a "mindless cook" following the standards blindly (Timmermans and Berg 2003: 73). This can be said to be a path between those who claim that standards stifle work practices and deplete workers creativity and personalized approach, and those who claim that standards improve quality with reducing inappropriate variations.

2.5 Audits

In the report after the MS Star Java accident, one of the conclusions was that an audit will not necessarily identify non-conformities between an established procedure and actual work practice. I will not try to give an exact definition on what an audit is, because there is no agreement what it really is (Power 1999: 4), and how it distinguishes from for example an inspection. Audit processes lack criteria of what they can and cannot do, because of this the question of its failures are often contested (Power 1999: 25). The term audit is nevertheless something which occurs quite often in the industry. Classification companies' role is in addition to develop standards, to verify and to document compliance with these, something which is done with, among other things, audits. These verifying processes are standardized audits with the intention to control compliance with written procedures. In this thesis the focus will be on what the manuals described as audits, and not discuss how audits in general can differ from each other.

The deregulation of the financial markets in the 80s, delegated much enforcement of rules to auditors (Power 1999: 32), which is very similar to the situation in the shipping industry. He claims that audited organizations often develop their own system of control, and that auditors focus on these systems when auditing (Power 1999: 82). I will argue that the safety management system is such an internal control system. Atkinson and Coffey claim that

written material are social facts, constructed in socially organized ways. One cannot learn through records only how an organization actually functions (Atkinson and Coffey 1997: 47). In Power's words, "*are or are not* (the audit processes) *loosely coupled to their organizational environments as mere 'rituals of inspections', or whether there are nevertheless real impacts on core activities, are an empirical issue"* (Power 1999: 89).

In general, documents do not stand alone as they often come as a result from other documents (Atkinson and Coffey 1997: 56). I will not go into detail on how the SMS is socially produced. I will only describe some of the key conventions the SMS is based on. I will emphasize that this does not mean that I do not consider the cultural values within the safety manuals as important, but these values will due to the limitation of the thesis not be part of my analysis.

In addition to the audits done on the SMS, the classification company did also similar technical inspections on the ship. How the ship is constructed is just as much a standard as the SMS, and has the same requirements of being audited. I will briefly comment on this later.

2.6 The constructivist approach to risk

The constructivist approach to risk differs radically from the technical and economic approach. Constructivists reject risk estimation as something that can be wholly objective (Shrader-Frechette 1991: 31). They do not think that risk estimates are value free and that it is an error to describe lay estimates as merely "perceptions". Risk is a social construct and it is not possible to determine whether a risk is "true" or not, because it is always mediated through social interpretation (Renn 2008: 22). Future possibilities are not related to calculation of probabilities, but to group-specific knowledge and vision. Thus there should not be any distinction between an "*engineer's and a house wife's"* opinions when having to do risk decisions. Translated to the shipping industry, the constructivist approach suggests that

there should not be a distinction between for example risk assessors from a classification company and boatswains on board a ship when judging risks.

If lay people's risk perceptions should count just as much as "experts'", some general findings on how these groups of people perceive risk are important. Risk perceptions can vary considerably between social and cultural groups (Renn 2008: 21), though there are some similar characteristics. *Volunitiarization, familiarity, control, catastrophic potential, equity and level of knowledge seems to influence between perceived risk, perceived benefit and risk acceptance.* Frequency is not seen as particularly important, but people's own experiences are (Renn 2008: 103). Information that challenges perceived probabilities that are already part of a belief system will either be ignored or downplayed.

Slovic claims that laypeople's judgments of risk are first and foremost related to hazard characterizations. If the catastrophe potential is big, it is likely that people are more averse to it (Slovic 2000: 148). Accidents will also often influence people when they later judge risk (Slovic 2000: 152). A rare accident will reveal information about possibilities of the event. This will work as a signal that breakdowns can occur in systems or that people might be more worrisome about it, and thus have what he calls signal value. This is something emphasized by the AIB after the M/S Star Java accident, noting that one of the reasons for the accident was that there had been no previous incidents with the crane, and thus no signal value.

All the above mentioned elements are part of the lay people's experience and thus cultural values. These cultural values will influence when risk decisions are made. Experts as well as lay people can be said to be influenced by cultural values. Under follows a brief summary of Brian Wynne's research on Cumbrian sheep farmers after the Chernobyl accident. I will later

in the thesis discuss in relation to how the crew on board the ship was not included in the actual investigation after an explosion on one of the ship's boilers.

2.7 Wynne and the Cumbrian sheep farmers

The distinction between a "lay man" and an "expert" can sometimes be quite blurry. There are situations where lay people can function just as much as experts as scientists, and where the scientific perspective can be just as social and value laden as other perspectives. On a ship, engineers work every day in relationship with technology, knowing its strength and weaknesses. However, the crew has little or no influence on investigations when incidents happen, something are similar to what happened in Cumbria after the Chernobyl accident.

Brian Wynne's article about Cumbrian sheep farmers after the Chernobyl accident shows how lay people can work as experts and challenges when science is standardized. In 1957, the Sellafield-Windscale site suffered until then the worst nuclear accident, when a nuclear pile caught fire and burned for a few days till the fire finally was put out. The accident caused nuclear pollution on the much of the same fields that later were to be polluted by radioactive precipitation caused by the Chernobyl accident. As a consequence the farmers had to pour away condemned milk for several weeks afterwards (Wynne 1992: 285).

After the Chernobyl accident in 1986, the soil in Cumbria was once again postponed for instant radiation, when radioactive clouds spread to the Northern parts of the UK. The first scientific advices from the government however, stated that there would be no radioactive effects in Cumbria after the Chernobyl accident. This was changed a few weeks later when the minister of agriculture banned sheep sales and movement in several of the affected areas. The ban was at first supposed to last for three weeks, but was extended on indefinite time,

causing severe economic harm to the farmers. The predictions the scientist had presented were based on a model that the plant roots would absorb the radioactive precipitation. However, the models the scientist used were based on alkaline clay soils, not the acid peaty soil found in Cumbria. Consequently the predictions were wrong, the grass remained radioactive. They had "standardized" soil, which was to be fatal for the sheep farmers.

The aftermaths of the Chernobyl accident reveled deep mistrust between the farmers and the scientists, relating back to what happened at the Sellafield in 1957. Many of the farmers did not believe that all the radiation came from Chernobyl, but from the Sellafield. Their perception of risk was a historic process dated from 1957 (Wynne 1992: 292). The farmers started to gather evidence that could prove their beliefs about radiation. When doing this, they detected that the same places where low laying clouds of steam from Sellafield was, was the same places with high level of radiation was after the Chernobyl accident. This gave strength to their theory about that it was actually the Sellafield sight that were causing much of the radiation, and not the Chernobyl accident. By gathering data on the same principles as the scientists, they were able question a lot of the research coming from the government. They "proved" that the radiation actually was coming from the Sellafield plant, not from radioactive fallout from Chernobyl.

The research on Cumbria after the Chernobyl accident shows that previous research influence scientists' work. The scientists involved in Cumbria were influenced by former research on soil something which were influencing their scientific advices. This shows that the scientific perspective is just as socially grounded, conditionally and value laden as lay people's (Wynne 1992: 297).

When ships are constructed, the construction has to comply with standard requirements from a classification. This includes all major technical machinery inside the ship as well. People on board ships are not included in these processes, and have to take for granted the calculations done by other engineers. I will later discuss how an incident on board is similar to what happened in Cumbria. The crew, as "lay people" used scientific explanations showing that there were other possible other outcomes of the investigation, than the conclusion from the investigators.

This chapter has tried to identify some of the key characteristics of some of the approaches to risk. I have also tried to show how these approaches can be found and dealt with in practice. That said, between these approaches, there are many other types of approaches. In this thesis, the technical, the economic and the lay people's approach are the ones I will discuss. The main difference is while the positivist side thinks risk is something objective and measurable, constructivist claims that risk is socially constructed and thus only perceived. I have also tried to show how scientific perspective is just as socially grounded, conditionally and value laden as lay people's.

In the introduction I stated that I will argue that technical, the economic and the lay people approach all can be said to be found on board the oil product tanker I was going to travel with. The next chapters will give an account of my trip with an oil tanker for just under one week when it was travelling in the Northern Sea reading the SMS manuals, observing and interviewing the crew. The trip was to reveal information about how the approaches to risk were different among the various actors and the implications these lead too, when manuals were supposed to be taken into use.

3.0 The trip as a case study

I had decided that a good way for studying risk perceptions in the shipping industry was to do a case study by spending time with the crew on board a ship. A case study is a *"detailed examination of a single example"* (Flyvbjerg 2006: 3), and this thesis is a detailed examination of my trip. The reason for choosing a case study is in Windgardner's words to *"concentrate on a single phenomenon or entity, the researcher aims to uncover the significant factors characteristics of a phenomenon" (*Windgardner 2007: 5*).* This is what I hope I will achieve with this thesis.

Flyvbjerg claims "*that it in the study of human affairs, there seems to be only context dependent knowledge"* (Flyvbjerg 2006). One of my main arguments in this thesis is that one has to acknowledge cultural values when doing science. This is not the only way cultural values within actors are subject to my research. Myself as the researcher is the primary instrument for data collection and analysis, and I am just as influenced by cultural values as other actors. I will now describe the process for getting the free pass on board the ship, and how this influenced my research in the case of me as a researcher, data collection and the relationship I developed to the crew members.

Even though this is a case study, and thus limited to cover only this ship, I will argue that because of similarities in the shipping industry, it is possible to do some generalization from it. The SMS is a standard for all ships that requires classification. This means that the system will be found on board several ships. M/S Star Java and ship which is in focus in this case, used the same classification company. Even though it is not certain that the SMS was implemented in the same way on board all ships, this study will thus possibly point out a few general challenges when it comes to different risk approaches in the industry.

3.1 Process of getting on board

The process of getting on board to an oil tanker was going to be much more difficult than I had imagined. Even though it lasted for several weeks, and therefore delayed my gathering of empirical information, it gave me a good insight into the shipping industry. In the end, the trip was going to reveal that there were different approaches to risk found on board, and about the relationship between humans and technology.

To get on board the ship was important. Not only because it was on the ship that I was going to observe and interview the crew, but also because it was there the SMS manuals were. The SMS manuals were regarded as company secrets, and the crew was thus not allowed to mail me any of the manuals. To read the manuals, I thus had to be on board.

As I explained in the introduction, I knew one person working on an oil tanker, and contacted him and asked him whether it was possible for me to spend some time on board the ship he was working on to research on risk approaches and the SMS manuals. Throughout my work on the thesis he had the role as key informant. To have a key informant is normal when doing such overt observation (Gilbert 2008: 272), and he was very valuable for getting the information I needed. His answer to my request was positive, but a few confirmations from his superiors were needed for me to be allowed to get a free pass agreement. In general, overt observation access is accomplished through negotiations with a gatekeeper (Gilbert 2008: 272). The gatekeepers to get on board this ship were several. My contact person told me that I needed accept from the captain, the chief engineer and the company head office. In addition to this, there had to be enough available cabins on board the ship.

Only a few days later I got confirmation from my contact person that the captain and the chief engineer were positive to have me on board, and that it would probably be enough available

cabins. The only thing that was missing now was a confirmation from the head office, but a request was sent, and an answer was expected in a few days.

The answer did not come in a few days. Instead, the process lasted for several weeks. When I talked to my contact person, it was clear that the free pass agreement was treated differently than a "normal" agreement, and it seemed like the reason was that I was a student. My contact person told me that negotiations went on between him and the crew manager at the head office. He was seemingly skeptical to let me get on board. Reasons they gave for not letting me on board varied, from not having enough available cabins to claims that they needed me to get a specific health certificate as well as a comprehensive security course before being allowed to enter. This was according to my contact person something they never had claimed for any visitors before. In retrospect it is easier to understand why they were skeptical to have me on board. First of all they had no previous experience with academics working on board. That they were afraid of me writing negative things about the company seemed pretty obvious, and was something I would later get confirmed. Secondly, I was only an expense for the company, because of extra money per diem. In other words, there were no reasons for the central office letting me travel with the ship besides pleasing me, something which there was no particular reason they should do.

After another couple of weeks, I got information that I should send an application to the central office, describing in detail who I were, what I was going to do on board, and what I would use my data for. I decided to be very humble, emphasizing that I was not going on the trip for revealing anything negative about the ship, but that it was a very interesting case from an academic point of view. I even suggested that the company could be included in the preparations for the trip, asking them if there was anything they wanted me to focus on, so that they may have some output from my thesis.

After waiting for almost two weeks for the response from the company, I started to phone the company head office. I got in contact with the crew manager. He said he had guilty conscience for not letting me know whether or not I was granted a free pass on board. However, he had decided that I was allowed to be on board the ship for as long as I wanted, asking whether I needed to be on board for as long as half a year. They still needed a couple of weeks to do some kind of consideration on my application, but as the crew manager told me *"when I decide on something concerning these questions, the company follows my advice".* One condition he gave for allowing me to enter the ship was that I had to sign a paper stating that I was not going to write anything negative about the company no matter if it was true or false (sic). Because I had no plans of revealing the company name, nor any of the crew members I was going to interview, I had no problems to accept this condition. It is a good example though, how skeptical the central office was to let me on board. Nevertheless, everything seemed now to be in order. The need for a health certificate and security course was suddenly not an issue of concern.

Later the same day I informed my contact person that I had been given a positive answer from the head office, and he told me that he was going to see the captain to ask when I could come on board. Late next evening he phoned me, telling me to come to the ship next morning for departure. Because the summer was approaching, and with that vacation for many of the crew members and lot of substitutes on board, the master thought it was best that I took the trip right away.

With the negotiations lasting for several weeks, gathering of empirical data was severely delayed, something which was troubling for me at the start. However, the process also gave me information about the industry, especially the relationship between people on shore and off shore. I will also claim that my troubling relationship with the central office was later

going to give me an opportunity to get closer in my relationship with the crew, and also understand why they were skeptical about things posed on them from the "outside world".

3.2 Entering the ship

The ship was in shore at an oil refinery facility at the coast of Norway. An oil refinery is a facility where crude oil is refined into more useful oil products. These products where in fact what the oil product tanker I was going to travel with carried, some of which are extremely easy flammable (as an example, jet fuel's, which is one of the oil products the tanker carried, flashpoint is 38°C). Because of enormous danger of explosions, all open fire is prohibited and to my surprise even cell phones were not allowed to be carried openly, because of danger for explosions. The facility is highly secured. When entering through the two gates, one must have clearance from either the oil refinery or one of the ships one are entering.

The ship was an oil product tanker, carrying different kinds of oil products, mostly the ones you find at a petrol station. It was mostly traveling at the coast of Norway, but took also trips to the continent. This meant it was often traveling in close waters with a pilot, and traveling to shore. It was about 140 meters long, weighing 30000 tons. It was in my opinion a huge vessel, carrying explosive liquid. It had a crew on 17 persons. A captain, 3 officers, 3 engineers, 1 motorman apprentice, 1 fitter, 1 cadet, 1 housekeeper, 1 chef and 5 boatswains. In addition to this there was a man working for a boiler company on board.

When I first came on board, I met with some of the crew members. "So you're the man he has been fighting for", one of them said, referring to my contact person. This conversation turned into talking about the crew department in the company, and they were not speaking very positive things about them. A first indication on my presumption about tension between the crew and the company head office was thus confirmed.

A short while after I came on board, I had to go to the captain's office for check-in. This is a standard procedure for everyone traveling with the ship. After a conversation with the captain, also giving him my passport for reasons not known, I was given the free pass agreement. The free pass agreement was a document stating that I was allowed to travel with the ship under certain circumstances, and was a part of the general company policy. I had to follow the ship's general safety policy and go through a safety course. It also stated that the company had no responsibility in case I was involved in an accident.

(Photo by Egil Heinert 2009)

The gathering of written data material was in general a challenge. The captain informed me that I was not allowed to do any copying of the manuals (I would later get an exception from this with the risk matrix and the pre arrival checklist). For some reason however, I could write anything I found of interest, including writing direct copy of the manuals on my computer.

The chapter on critical operations and the chapter on risk assessment is thus a copy of the manuals on board, which I wrote on my computer during my stay. Because of not being allowed to read the manuals prior to my trip, I had to make relative quick decisions about what kind of documents I was to study on board. This may have had an influence of which documents I chose to focus on, but this was the conditions I had to work under.

A few hours after my meeting with the captain, I was to report for the safety course. I was going to have the course together with a man that was working on a boiler down in the engine room.

3.3 The safety course

The safety course was my first meeting with the SMS on board the ship, and I got a first look on how these manuals were dealt with in practice. As an introduction to the ship, the course was valuable for me, but when it came to actually handling a situation on board it would prove to be a lot more challenging. The checklist filled out after I had finished the course, was not actually representative for what I had learned from the course. In the case for the thesis empirical support on standardization were valuable. I got myself an experience on how standards not always work as intended. Even though I in a way shared the course perception of a critical situation, the course was difficult to understand.

The course was compulsory for all visitors and workers on board the ship. The ‘boiler guy’ had been on board at least two periods prior to my trip, but had never taken the course for reasons unclear. As the safety officer said “that is not good”, and of course not according to the manuals. The course focused on familiarization with the ship, emergency exits and fire protection equipment. As a rookie sailor, I have to admit the course was quite overwhelming. We went on a round trip on the ship, visiting almost every part of it. During this, the safety

officer showed where the fire protection equipment and the emergency exits were and also where to meet if we had to evacuate the ship. I had never been on board on an oil tanker before and had problems with digesting all the new impressions. I had neither experience with any of the fire protection devices that were shown, and an "easy" thing such to know where the emergency exits were, was challenging. Much of the safety equipment was what I will call rather technical, and as person with not much of a technical background I had severe problems with understanding how I should operate the different emergency apparatus.

Even though I had problems with understanding the different emergency equipment, the course was a valuable for me when it came to familiarization. Even though I had almost no idea where for example the emergency exits were after the course, I was to recognize these later during my trip.

After the course, a "check list" scheme was filled out confirming that I had taken and understood the course. The check list states different points we were supposed to have gone through and understood. To say that I had actually understood all the different points on the scheme would be an exaggeration. However, it would probably have taken hours for me to actually understand everything that I was supposed to, and I did not want to bother the safety officer with that. He had to do the course on his "spare time", and I thought it would be best to be a yes-man when I implied that I had understood it all.

When I reflect on the safety course, is it retrospect easy for me to understand why I did not bother the safety officer with the fact that I did not understand much of the course. I had just finished a negotiation process for getting a free pass that had lasted for a couple of months. I did not want to contribute to any more work from none in the company that I had already done. If I had got the free pass without going through these negotiations, I will not out rule

that I would have asked more question. In my opinion this shows that me as a researcher is just as other actors in this thesis affected by cultural values and experience.

Something which is possible to draw out of these findings, are that the checklists and the safety course was not made for "tourists" as me. Some kind of technical background, or experience with handling emergency equipment is almost a condition to get much sense out of the course. I did understand however, that there was one thing one had to avoid, and that was fire. And in case of fire, I would try to find the nearest emergency exit. The standardized scheme did not suit a person with no previous experiences with handling the tools, and is an indication on that one have to have some knowledge about what is going on. I was a lay man, who shared the course's perception of dangerous situations, but it still gave little meaning, something which support that work with guidelines requires proficiency.

Secondly, after I'd had a few conversations with different crew members, they indicated that they did not use the SMS manuals. I was very open about what my research, and comments the different crew members had when discussing my research, made it clear that they did not use them. This was later confirmed when I interviewed different crew members one on one, where I explicitly asked if they used the SMS manuals.

My presumption that the crew members did not use the SMS manuals was confirmed. The next three chapters will discuss why the crew members did not use the manuals as intended.

4.0 Critical operations

In the introduction, I claimed that if the crew did not have the same opinion on what a critical operation have, it is not likely that the manuals are implemented as intended. In the theory chapter I tried to show standards should be meaningful for workers if they are going to work

as intended. If there was different opinions between the manuals and the crew what were regarded as critical operations the manuals are less likely to be implemented.

In this thesis, critical operations will be regarded as operations which generally needed extra attention and different measures had to be implanted when doing these. As I have said I will not discuss how the SMS were socially produced, but an intuitive understanding of a "critical operation!" could be that it was because the chances for accidents when doing these operations where greater than other operations. I do not underestimate that the manuals and the crew can have different perception of what "critical" is. There is no reason for this concept being less socially constructed than the "risk" is, but will not be a part of this analysis.

This chapter will give an account of what the SMS manual regarded as critical operations, and I will compare this with operations the crew regarded as critical. Methodology I used when collecting data and preparing and conducting the interviews will also be presented. I will also describe the context for the interviews, and explain how it influenced the methodology I used. First however, I will give a short description of the different conventions and authorities the manuals are based upon

4.1. An introduction to the manuals

The free pass agreement stated that in general I was not allowed to walk around in the ship without being accompanied by a crew member or a company representative. This was something which I soon discovered not to be enforced, and I was allowed to walk around freely. I have to admit this was practical, not only for me, but also for the crew which did not have to babysit me every time I wanted to observe something.

I was told that the SMS manuals were available at a computer down at the engine's control room, inside the engine room. In the control room, there was a window out to the boiler flat

area part of the engine room. This made it possible for me to observe the crew, while they were working. This meant that I was able to be in contact with and observe the engineers while I read the manuals. I could also go along when they did something I thought was of interest, such as different maintenance work etc.

The manuals were based on national and international regulations and laws. Hänninen (2008) has identified 5 bodies having risk regulation at sea as one of their main area of work. 1) The International maritime Organization (IMO), which role is to formulate and promote new technical regulations, 2) National authorities, which role is to implement the IMO regulations and set and control local regulations, 3) the classification societies/companies, which inspect vessels and set requirements for insurability, 4) ship owners, which order and operate vessels over their life cycle, 5) the ship builders, which design and build ships and repair damages.

The ship was subject to a number of regulations formulated from these five bodies. Three of them were from the IMO: MARPOL: International Convention for the Prevention of Pollution from Ships; SOLAS: International convention for the safety of Life at Sea and ISM: the International Safety Management Code. There were also regulations that were directed to the ship because it carried oil such as ISGOTT: International Safety Guide for Oil Tankers and Terminals, which is a manual from the Oil Companies International Marine Forum (OCIMF). ILOs Accidents on board ship and in the sea port manual was also briefly mentioned.

In addition to the international regulations, the ship was subject to national regulations. In the safety manuals only the American convention Oil pollution act of 1990 and general regulations from the US Coast Guard were mentioned. These rules do only apply for ships that are in American waters and thus not particularly important for this ship. Though there were only American conventions mentioned in the SMS manuals it does not mean that there were not local regulations set from Norwegian authorities. One “Norwegian” regulation is for

example that it is not allowed for tankers older than 20 years to operate between oil installations in Norwegian waters and Norwegian ports, though this is not of relevance in this thesis.

There were a total of 11 SMS manuals, listed from 1-10, in addition a manual P, that in some way were concerning safety and risk. Their focuses differed. Some were focusing on security, which I did not have access to because of password protection, while others focused on pollution or safety.

I have already stated that the manuals were only available on the ship, and that I was not allowed to take any copies. I therefore needed to make a quick decision about which manuals I was going to study. I chose to focus on manual 10. Manual 10 was the manual concerning critical operations and risk assessment. Other manuals could refer to the risk assessment as well, but it was only manual 10 that gave a thorough description of how risk should be assessed, and was thus the most relevant for my research question.

Manual 10 was roughly split in three sections: 1) how to identify critical operations 2) how to properly assess them 3) how to decide what is safe enough. Because I was not allowed to take any copies, I had to write everything I found of interest over to my computer. The parts written in italics are thus a copy of what I found in the manuals.

4.2 Critical operations in the manuals

The “critical operations” were listed as follows:

1. *Cargo and bunker transfer operations*
2. *Tank cleaning operations*
3. *Navigation in close or high traffic areas*

4. *Operations that may cause sudden loss of maneuverability*
5. *Reduced visible conditions*
6. *Heavy water*
7. *Machinery operations on automatic safety systems*
8. *Mooring and tugs*

According to the manuals, critical operations demand more attention than other operations. Some, such as during mooring and tugs and under navigation in close or high traffic areas, the captain has to be present on the bridge at all times. Other, such as tank cleaning operations, needed "proper" risk assessment. But why these 8 operations were particularly critical, the manuals did not say.

There were also "smaller" operations that according to the manual needed extra attention. In the risk assessment section of manual 10, eight operations were mentioned for requiring this. These were

1. *Work in tanks and other confined areas*
2. *Hot work outside of approved workshop*
3. *Cold work in areas where hydrocarbons can be present*
4. *Work more than 2 meters above deck*
5. *Work in areas with open hatches*
6. *Work over open sea*
7. *Lifting over pipes or systems under pressure, or containing hydrocarbons*
8. *Work on or in the vicinity of pressurized equipment*

The manuals stated that *"Although no special risk is foreseen, a SJA/RA should be performed if the job includes any of the (below) listed activities"*. I will give a thorough discussion about

the SJA/RA later. In this part however, it is important to note what was regarded as particularly critical, and thus risky, by the manuals.

4.3 Interview preparation

After being on the ship for 4 days, I was going to conduct the interviews. I had spent my time with observing the crew, getting to know them and their tasks on board while I also spent time studying the manuals. This was in addition to research itself, also preparation for the interviews, which I was hoping could further develop my understanding about the crew members' relation to risk, critical operations and the SMS manuals.

The interviews were "semi-structured", in the way that I conducted them with open ended questions (Leech 2006: 665). The questions were (1) "what do you put into the concept of risk?" (2) Are there any operations that you regard as critical? (3) What do you do for minimizing risk? (4) Are using manuals a part of your daily work practices? (5) Do you use take 5, tool box talk or SJA/RA? (6) Do you trust machines and technology on board? (7) What do you think about audits and inspections?

The question where in general asked in this order. However, often they glide into each other. This was especially the case when I asked about risk, where the crew members often answered through explaining critical operations. I will return to this later.

The crew works on average 12 hours a day. Usually, the start at 0800, and end the day between 1800 and 2000. In addition to this, watch duty was normal. When for example a pilot is on board, regulations required an engineer to be on duty down in the engine room, no matter if it was in the middle of the night. This meant that they had limited spare time, and because of this I decided to the interviews when they were working or they were close to their work site, because I did not want to bother them the short periods they did not work. It is

possible that the answers I got from the interviewees were not affected by this, as it can be easier to give examples from what you are actually doing. The third officer was for example interviewed while he was supervising a bunker transfer operation and the fitter while he was doing maintenance on a shaft pipe. The engineers were interviewed in the engine control room.

A consequence of interviewing the crew members on-site, was that I could not use tape recorder. The reason for this was the working environment was noisy, and it would not be possible to do tape recording with sufficient quality. I had thus to rely on taking notes. After the interviews were finished, I wrote them out on my computer which I had brought with me. With not having the interviews recorded, the possibility of going back to listen to interviews was gone. In my research, I had to depend fully on my notes which are not as precise as listening to the interviews on tape, but that was a price I had to pay. I brought my notebook around with me not only when I was conducting the interviews, but also when only observed and had conversations with the crew.

The on-site interviews I conducted are related to what is known as ethnographic interviewing. Sherman Heyl defines ethnographic interviewing as

"those projects in which researchers have established respectful, on-going relationships with their interviewees, including enough rapport for there to be a genuine exchange of views and enough time and openness in the interviews for interviewees to explore purposefully with the researcher the meanings they place on events in their world" (Sherman Heyl 2001: 369*).*

With the limited time I had on board, the interviews I would carry out would not fully fall under this category. This is because my relationship with the interviewees hardly can be said to be on-going relationships. However, I will argue that even though I was not on board for more than just under one week, I was able to develop a relatively close relationship with the

crew members. In this respect, I will argue there were two areas that specially worked in my advantage. First of all, the crew members knew that I have had trouble with the central office to get my free pass agreement. Several crew members did not like the central office much. The fact that the central office was skeptical of me, made them a common enemy for me and the crew members, and thus they had a reason for trusting me more. Secondly, when I *was* on board, I interacted with the crew all the time, both during their workday and during all meals. This made me able to communicate and observe with the workers throughout the day, and I could thus really show that I *was* interested in what they were doing. In Sherman Heyl words I wanted them *to teach me what they were doing and why they were doing it* (Sherman Heyl 2001: 369).

Reading the manuals in the engine room also helped me prepare for the coming interviews with using what Carolyn Baker calls *'membership categorization devices'*, which is an analytical tool for treating data. In her perspective:

> *(1) interviewing is understood as an interactional event in which members draw on their cultural knowledge, including their knowledge about how members of categories routinely speak; (2) questions are a central part of the data and cannot be viewed as neutral investigations to speak – rather, they shape how and as a member of which category the respondent should speak; (3) interview responses are treated as accounts more than reports – that is, they are understood as the work of accounting by a member of a category attached to that category* (Baker 1997: 131).

The data collected from the interviews is not collected to locate inner beliefs or to seek actual description of social settings, but rather to identify speakers' methods of using categorization and activities in account (Baker 1997: 131). This is a way for identifying cultural knowledge and logic in use, knowledge that is visible when people account to each other.

Spending time with the crew made me aware of the different positions the crew members had, and was helpful for directing the question in a way they could understand. When analyzing the interviews, membership categorization was also a helpful tool for understanding different approach based on the different cultural values within the crew members.

To have these in mind when analyzing the interviews is also important. The different crew members had different main tasks on board the ship. As I have mentioned, familiarity is one area that influence when people perceive risk. Different positions and work tasks on the ship could have an effect when regarding what critical operations were.

I felt that the crew was quite interested in what I was doing on board. They could often ask me what I was doing and if I found something of interest. As noted earlier, I was very open about what I was actually going to study, and they seemed interested whether or not I was able to find something which could help me writing my thesis. To be open about what I was researching, was a conscious act. It is important to make the crew at ease with my project (Leech: 2002: 666). When they asked question about whether I found anything of interest, I explained to them that I read in the SMS manuals and that it was quite interesting to read them. The general reactions I got were that they did not know what these kinds of manuals were, or that they seldom used them. This shows two important areas. One is, of course, that they did not use the safety manuals. The other area is my relationship to the crew. I was obviously interested in what they were doing, but they were also interested in what I was doing. Being so open about my research, I think I improved my relationship with the crew members. How they later answered my questions, indicates in my opinion that I was relatively successful in doing so.

4.4 Critical operations – the crew member's opinion

In this part of the thesis, I will describe the answers I got from the interviewees about what they regarded as critical operations. As I have explained I asked other questions as well, something I will return to when discussing approaches to risk.

I conducted a total of 7 interviews. The interviewees were the captain, the chief engineer, the 1. engineer, the 3./safety officer, the 2.engineer, the fitter and the motorman apprentice. The reason why I chose these crew members to be interviewed was mainly because I focused on crew members down in the engine room. This was the area where I spent most of my time and gained knowledge about the specific work situations. This made it easier to interpret the interviews, because I was familiar with the different work tasks they related many of their answers to. That I only interviewed these seven does not mean that I did not get information from other crew members at all. I had conversations with other crew members as well, but they were not included among the interviewees. This could have an effect on the data I got from the interviews.

Before starting the interviews, I explained to the crew members that they were granted confidentiality, and that I thus not would use their names or the name of the shipping company in my thesis. This seemed not to concern them much. As one said *"I doubt that there are anyone interested in what a sea farer from Norway does, down in the Netherlands"* (I had earlier told them that I was a student at Maastricht University*).* This could be an indication that when they answered my questions, they answered honestly.

In general, the operations they regarded as critical, were also listed in the manuals as critical. Work in tanks was mentioned by three members of the crew (the fitter, the captain, and the 3. officer). Work that included hot liquid, which is what the manuals describes as "hot work", was mentioned by four crew members (the 1. engineer, the 2. engineer, the motorman

apprentice and the 3. officer). Another area that was mentioned by 3 crew members was crane operations (the 1. engineer, the 3. officer and the 2. engineer). Navigating in close or high traffic areas was only mentioned by the chief engineer. Work above deck was only mentioned one time (the 3. officer), and so was cold work (the 1. engineer) and machinery operations on automatic safety systems (the 1. engineer). All operations mentioned by the crew as critical was to be found in the SMS.

For an outsider it is perhaps strange that so few operations were regarded as critical by the different crew members. The manuals mentioned several more. During my stay only three of the manual described critical operations were present: *cargo and bunker transfer operations, navigation in close or high traffic areas* and *mooring and tugs*. The ship was an oil product tanker and these kinds of tankers are often at shore. Hence the ship was often to maneuver in close areas and had also a lot of mooring operations. The reason they were at shore was to transfer cargo and bunker. This was thus also an operation with a relative high frequent. It was quite striking that none of them was mentioned by the crew as critical operations in the interviews. It can have something to do with what Slovic indicate has an influence on perceived risk, perceived benefit and risk acceptance. Familiarity, control, and level of knowledge seem to influence these areas. This was routine work, with relative high levels of familiarity, control and knowledge. This could be reason why the crew members did not mention them as critical.

I will also note that the operations the different crew members mentioned as critical were close to their ordinary work tasks. Perhaps the most striking example is work in tanks, that were not mentioned by any of the engineers, but by the fitter, 3 officer and the captain. Engineers are not as much involved when people are working in tanks, and this could have something to do with them not mentioning these operations at all. Crane operations were also only mentioned by crew members that actually used the different cranes on board.

With this data, I will argue that different opinions about what a critical operation was, is not likely to be a main reason why the crew did not use the manuals as intended. The correlation between what the crew members and the manuals regarded as critical operations was there, even though the crew members mentioned fewer critical operations than the manuals.

In the interviews I asked questions about how they understood the concept of risk. The answers I got when asking these questions were interesting, not correlating in the same way to the SMS as what was regarded as critical operation. Could this be an explanation of the non compliance with operating procedures and actual work practice?

5.0 Risk assessment in the SMS

Instructions on how to assess risk was explained in manual 10. The three standardized risk assessment processes "take 5", "Tool Box Talk" and the Safe Job Analysis/Risk assessment (SJA/RA) were all supposed to be tools for the crew to use when assessing and limiting risk. However, they were not implemented as they were supposed to. I will under present a copy of the three risk assessment processes and how they were supposed to work in practice. I will compare them with the three approaches to risk, and argue that the reason why they did not functioned as intended, was the difference in risk approach between the SMS and the crew members.

The risk assessments tools were also in a way embedded in other technology specific manuals. The idea was to use the same risk assessment process when doing different operations. In the manuals for shifting filters and how to use the crane in the engine room, the manuals referred to the SMS manuals as first procedure when preparing the task.

Take 5

The "Take 5" program consisted of the following five steps that workers (individual or groups) should follow when performing a task:

1. *Stop: Before proceeding with a job, ask a series of questions such as: "Is this a high frequency routine job?" If not, safe job analysis to be carried out "Have I done this job before?" or "Have the conditions or locations of the job changed?"*
2. *Think: ask questions such as "What can go wrong?" or "can I get hurt doing this job?"*
3. *Identify: Identify any significant hazards by physically observing the work area before proceeding with the job. At this time, the "take 5" mental checklist is complete.*
4. *Plan: take appropriate precautions before proceeding with a job. Planning includes getting proper tools, equipment, PPE and any assistance required to complete the job safety.*
5. *Proceed: Once satisfied that all point have been covered, proceed with care.*

Tool Box Talk

Another way of assessing risks was the "Tool Box Talk". The Tool Box Talk is a quick discussion at the job site, before starting a job, between those involved and the supervisor. The purpose of a "Tool Box Talk" is to identify job steps, assess and mitigate risks, and consider control measures/task actions

The Tool Box talk was supposed to:

- *Highlight risks so that those involved are able to recognize and control any hazards they experience during the job, (heightening their awareness of required safety measures).*

- *Ensure the personnel involved assess the work site BEFORE commencing a job, allowing for thought and discussion about risk assessment and required health and safety precautions (by encouraging this assessment, risk identification becomes habitual and ultimately helps improve safety on board).*
- *Only takes a few minutes, as there is no need to write anything down*

Both the take 5 and the Tool Box Talk have risk limitation as their main goal. By proper assessing, risk limitation is supposed to be possible. It is important to note that neither say anything about what risk is, and thus not what acceptable risk is. It is up to the person who is doing the risk assessment to give a definition on risk. I will therefore argue that they are in a way "neutral" in their approach to risk, not using any of the three approaches to risk mentioned in the theory chapter. With the SJA/RA however, the situation is quite different. Under follows a copy of the SJA/RA part of manuals 10.

<u>Safety Job analysis (SJA)/Risk Assessment (RA) – A formal work group risk assessment exercise documented on a form</u>

All work which includes potential risk for personnel, environment or assets, or shut down on critical equipment/system shall be subject to SJA/RA prior to execution. When such work occur a time schedule of shutdown is to be included. If the agreed shutdown cannot be achieved, a further risk assessment is to be approved by shore management. For all intended changes SJA/RA must be carried out. A risk assessment shall be made to identify any hazards to which workers may be exposed in their work. Such risk assessment shall be made on regular basis, and

- Whenever new working equipment or new technology is introduced and
- Whenever other modifications are made to the organization or planning of work, which may affect the health or safety of workers.

1. The result of risk assessment shall be documented in writing.
2. If a risk to the safety and health of workers are identified, the necessary measures shall be taken to eliminate or reduce such risk.

If it is considered that the job is not covered by the company's instructions, it should be reported to the HSEQ system for implementation in the shipping company's SMS.

Method

The basic idea of the SJA/RA method is to divide the job into a number of sub tasks. Then to evaluate, which hazardous element is related to the individual tasks. The five elements in the method are the following:

1. *Select the job, procedure, etc, to be analyzed*
2. *Split the job into individual task*
3. *Identify the hazards and potential accidents related to each task*
4. *Develop means to eliminate, reduce or control the hazard inform all personnel involved*
5. *Document the analysis in the "SJA/RA" sheet*

Identification of hazards

During the execution of the SJA/RA the different sub-tasks shall be gone through step by step with the following focus:

- What type of damage may occur? (e.g. crushing, drop, fall, fire, explosion etc.)
- Are specific problems or deviations likely to occur?
- Is the task difficult or uncomfortable to carry out?
- Are there alternative – and safer – ways of performing the task?
- Is there a risk with regard to exposure of chemicals?

- What is the experience with similar tasks?

The identified risk related to the different sub-asks shall be evaluated and compared to the following categories:

- insignificant risk
- Acceptable risk, action not necessary
- Risk reducing measures to be implemented
- Job is considered unsafe, superior manager to be notified

The Risk Matrix shall be implemented for each permit to work, for determine level of risk. Risk reduction measures to be initiated according to the specific matrix determination.

Risk matrix

A 'risk matrix' is a table that has several categories of "probability," "likelihood," or "frequency" for its rows [columns] and several categories of "severity," "impact" or "consequences" for its columns [rows] (Cox 2008: 497). The idea is to mathematically explain the probability (risk) for an adverse event to happen. Haimes (2006: 293) explained this in the way that risk is "the result of a threat with adverse effects to a vulnerable system". The risk matrix is systematical way of doing this.

The shipping company had its own risk matrix (model 1) defining different levels of risks. All risk assessment on board should be taken on the basis of this scheme. The idea was to, with the help of different risk identification processes, to properly identify and asses risk. Through the risk identification process, the crew was supposed to follow the matrix ending in three different colors: green (acceptable level of risk) yellow (medium risk) or red (not acceptable level of risk

Model 1:

HSEQ Incident Type					Degree of control/ Frequency Likelihood (1 - 5)					
Personnel Injury (PI) An event, which has resulted in personal injury or illness	**Water based Spill***	**Oil Spill**	**Property Damage**		**Very Unlikely**	**Unlikely**	**Possible**	**Likely**	**Very Likely**	
					Yellow area - Medium risk (M)		**Red area** - High risk (H) = not acceptable level of risk			
Very Serious Death or multiple serious injuries **LTI** (Fatalities + PTD)	> 500 m³	>100 m³	NOK >5 million	**Consequence / Hazard Severity (A - E)**	M (E1)	M (E2)	H (E3)	H (E4)	H (E5)	**E**
Serious Long term serious injuries **LTI** (PPD)	500m³ - 500 litres	100m³ - 100 litres	NOK 5 million - 200 000		L (D1)	M (D2)	M (D3)	H (D4)	H (D5)	**D**
Moderate Injury leading to **1 - 10 days** away from work **LTI** (LWC)	500 litres - 100 litres	100 litres - 10 litres	NOK 200 000 - 50 000		L (C1)	L (C2)	M (C3)	M (C4)	H (C5)	**C**
Slight Medical treatment / unable to perform all normally assigned work functions **MTC** + **RWC**	100 litres - 50 litres	10 litres - 1 litre	NOK <50 000		L (B1)	L (B2)	L (B3)	M (B4)	M (B5)	**B**
Negligible No specific treatment or loss of work Includes minor First Aid Cases (**FAC**)	<50 litre	<1 litre	No Cost		L (A1)	L (A2)	L (A3)	L (A4)	M (A5)	**A**
					Green area - Low risk (L) = acceptable level of risk				Medium risk (M)	
					1	**2**	**3**	**4**	**5**	

Definitions:

Lost Time Injuries (LTI) This is any work-related injury or illness that prevents a person from doing any work the day after the accident. Lost Time Injuries are the sum of Fatalities, Permanent Total Disabilities, Permanent Partial Disabilities and Lost Workday Cases (**LTI=Fatalities + PTD + PPD + LWC**).

Medical Treatment Case (MTC) Work related injury or illness requiring more than first aid treatment by a physician, dentist, surgeon or registered medical personnel.

Restricted Work Case (RWC) Work related injury or illness that renders the injured person unable to perform all normally assigned work functions during a scheduled work shift.

Total Recordable Cases (TRC) The sum of all work-related fatalities, lost time injuries, restricted work injuries and medical treatment (TRCs = LTIs + MTCs + RWCs).

Near Miss (NM): Situations that could lead to injury to personnel, damage to equipment or spill if the conditions had been slightly different.

Safety Observation (SO): Minor Non-Conformity such as "one time events" of missing sufficient PPE ore poor source segregation of waste (isolated matters) is examples of what can be reported as SO. Typical situations: slippery floors while washing, improvements with limited interest for other than own ship, smaller operationally matters that doesn't need attention from other than the ship itself etc. To be processed locally on the vessel.

In the theory chapter I argued that positivist claimed that risk was something objective and measurable. The economic approach builds on this by using utilities, and one is able to take positive effects into account when measuring risks. The approach will thus give an answer to the question what is safe enough. The risk matrix gives such an answer. If there is a possible chance for a slight injury, it is acceptable to presume with the operation.

Even though the risk matrix explains what is safe enough, it does not mention any beneficial gains for going through with an operation. Positive gains were not mentioned in any of the other manuals I read. Is it possible to say what is safe enough without including positive gains? The ship was working on a contract from an oil company. I was told that the oil company paid for the bunkers, but the shipping company had to pay for maintenance of the ship, wages and diet for the crew.

When risk decisions are made, decision on whether or not going through with a risk related operated decision one is supposed to consult the risk matrix. I have mentioned that beneficial parts of the risk are not included into the matrix. In other words the matrix is focused on expected harm, not expected utility. Evidence of production pressure is in general not easy to come by but I have now tried to show how it can have an influence in the industry (Perrow 1999). I will nevertheless argue that the matrix has the economic perspective even though the matrix did not include beneficial parts. The reason for this is because of the situation in the shipping industry. To get renewal of the contract from the oil company was of importance. In a troubling world market, it is not easy get a new contract from the same or another oil company. The contract the shipping company had with the oil company lasted through 2009, and was thus soon up for renewal. I was explained that it therefore was important to show stability and that the ship delivered oil according to schedule. The importance of production pressure in the shipping industry is supported by Perrow, who argues that a captain is judged in the ability to keep schedules (Perrow 1999: 181) which will be pressure for keeping the

ship going. In light of this I will claim that the matrix can be said to have the economic approach to risk

Talking to a fellow student, who is doing research on shuttle tankers in the Northern Sea, confirms this. In her, not finished, thesis, she explains how the shuttle tankers often are bending written rules, particularly level on waves when doing cargo transfer, are bent because of high cost of not going through with an operation. The crew was often talking about what was going to happen to the ship, and themselves, when the contract with the oil company expired, which was something that worried them. Therefore Even though it is not explicitly mentioned positive gains in the manuals, the economy side of keeping the ship going was important and I will argue that this was the "positive gain" side in the economic approach.

The Risk Matrix should have been implemented for each PTW (work permit) to determine level of risk. Risk reduction measures were to be initiated according to the specific matrix determination. I will argue that using the matrix thus requires that those who are going to use the matrix had the same approach to risk as the matrix. The question was if the crew members had a similar approach to risk. Would the standardized risk assessment function if the crew had a different approach than the manuals?

5.1 The crew and its approach to risk

The approach the SMS manuals had was close to the economic approach to risk, based on probability assumptions. If a crew member did not have the same approach to risk as the manuals, theory on standards claims that they would probably not be meaningful, and thus not function as intended. The approach the crew members had to risk was not something I could detect by only observing them, and I included as explained therefore a question about what approach to risk the crew members when I conducted the interviews.

The question I asked the different crew members was "what do you put into the concept of risk?" The question is in my opinion a pretty open question, giving the interviewees the chance of explaining risk in their own words. My idea was on the basis of the answers to try to reveal some general tendencies about their approach.

The answers I got from asking this question were in general related to tasks on board. Two explained the concept of risk through injuries on themselves. As one said: "when I think of risk, well, I have to admit that I am thinking of myself getting injured". Five crew members explained risk through critical operations that could go wrong. This could vary between answers such as *"risk are dangerous situations"* and more specific focus on a task *"well, for example, when I change filters, it can be dangerous, so that is a risk".*

I will argue that the social relationship between myself and the crew members, was affecting the interviews (Miller and Glasner 1997: 105). Because they knew I had read the SMS manuals, I was in a way the "expert" on risk. What I was not an expert on however, was the different work situations on board. The social difference was shifting in the interviews. When I asked the crew members what risk was, they explained this through how the different critical operations could be dangerous, they changed the positions so they became the expert, which in my opinion gave an even better view into the crew member's social worlds.

Perhaps the most typical example of this came from the fitter. At first, he had trouble with explaining what he thought risk was. He told me that he regarded the whole ship was a risk. After thinking for a while he referred to an accident on one of his prior ships. After going into a port for maintenance of the whole ship, the electric system on board was shut down. With knowing this, a worker was sent to paint on of the fan shaft on the ship. While painting, the captain decided that they had to turn on any of the parts of the electrical system, to have one last check whether or not the system worked. Not knowing that there was a crew member

down in the fan shaft, they decided to turn on the particular shaft the crew member was painting, causing severe injuries. The lesson he had learned from the incident, he explained to me was that one could not see the ship as separate parts, but as a whole system and thus the whole ship was in a way a risk.

In addition to the fitter, 3 other respondents had initial problems of defining risk at all. This was not a surprise and I focused therefore on letting them explain it when it came to use rather than meaning and, because this is often easier (Leech 2002: 666) and they then came then up with their explanations. By focusing on dangerous situations, I will argue that for these seven, risk equaled high risk. Hazard potential was a key in all seven crew members explanation on what risk was. Four gave examples on previous accidents that had cost lives or injured one or more crewmembers. Because of the general emphasis the crew members gave hazards and previous accidents, I will claim that for them, risk was equal high risk. The probability of that something adverse could happen, was not mentioned at all.

In chapter three, I argued that the different crew members did not use the SMS as intended. The answers I got when I asked whether or not they used these risk assessment tools, was that this was something they did not do. The exceptions were when it was mandatory to fill out a SJA/RA scheme because they had to. This was when during tasks as for example “cold-work” or “hot-work”, ref the chapter on critical operations, because they needed a work permit to be allowed to these tasks. When a SJA/RA was not mandatory, they did not use them. I continued on this area by asking whether they used the risk matrix when they actually did the SJA/RA, which was something they were supposed to do according to the manuals. Once again the answer was no from the different crew members. They explained that they knew how to fill out the SJA/RA schemes for being allowed to do to such tasks.

There were however one important exception among the interviewees. The 3. officer, explained that risk was the probability that something could go wrong. He also had a very different relationship to the safety manuals than the rest of the crew. For him the manuals were valuable tools for assessing risk. As he explained to me *"you can almost get an answer to everything in the manuals, they are really valuable, and I use them a lot".*

I also asked whether or not the interviewees used "take 5" or the "tool box talk" when preparing for a task. The answers were that besides of one, none of the interviewees used these risk assessment processes. The interviews thus confirmed that risk assessment tools in the SMS manuals were not used as intended.

When the crew members explained what risk was, everyone mentioned precautionary steps for making an operation safer. A typical answer was *"to use cranes can be dangerous, but I always thinks one or two times about the operation before I go through with it, to be sure that nothing critical can happen".* I will emphasize that I did not have to ask about precautionary steps, this was something they mentioned without me having to ask. Because risk equaled high risk, it is possible to argue they mentioned the precautionary steps to show that they took safety seriously. Two things were mentioned by all as important to limit risks, the importance of planning work, hereunder safety measures, and carefulness when doing a job for the first time. These are two areas that also are important in the take 5 (*"Is this a high frequency routine job?", "Have I done this job before?", "Plan: take appropriate precautions before proceeding with a job")* and the Tool Box Talk ("*Highlight risks so that those involved are able to recognize and control any hazards they experience during the job").* Even though they did not use the manuals explicitly, there were correlation on what they were supposed to do, and what they actually did. So there was a sense of compliance with the standardized risk assessment procedures, even though the manuals were not fully implemented.

An example of this was when I observed the motorman apprentice when she tested bunkers quality. The ship's fuel was bunkers, an oil product with very low quality. The oil quality could often vary, which have implications for how good the engine ran, and therefore needed to be tested. I observed the motorman apprentice, while she was conducting such an oil sample test. The testing process included chemicals which were toxic, which could cause allergic reactions. She explained to me how she used protective equipment. According to the SMS, a Take 5 would be the normal thing to do prior to going through with the task, but this was not done in the way the manuals describe it. This does not mean that she was not aware of possible dangers, quite the contrary, she was well aware of the dangers when doing the task. But testing was a large part of her work, and thus routine. Precautionary steps were here built into her task preparing process.

Experience from the past was of importance also when working with new technology. As the chief engineer said *"when you start working with new technology, machines and equipment, you are always cautious at first, then you get to know the technology, learn its strength and weaknesses, and know how to handle the specific items",* something which was a typical answer when I asked about the use of manuals. They had to use the manuals the first couple of times they were doing this specific task, but they would often with the direct use when they got to know and felt secure about technology.

This chapter has tried to give an indication about the different approach the SMS manuals and the crew had to risk. While the risk matrix is an example of the economic approach to risk, the crew's approach was much more related to hazards and previous accidents. The findings pretty much confirm Slovic's research, which emphasize the importance of hazard and signal value when lay people approach risk. It is important to emphasize that these characteristics does not come in a vacuum. Just as the Cumbrian sheep farmers the crew members approach

to risk *was in the terms of the societal relationship they experienced, as a historical process (Wynne 1992: 291).*

The interviews confirmed my presumption that in general, the crew members did not use the manuals as intended. Instead of using the manuals, they relied on their previous experience when doing different tasks. Because of very different approach to risk, the risk matrix was alienating, and did not make sense for the crew members. They chose therefore not to use it.

The exception was the safety officer. He had a similar approach to risk as the SMS manuals, and for him the matrix gave meaning. That he was the safety officer as well, could have influenced this in the way that he had different cultural values than the other crewmembers. However, I did not study the specific cultural values within each crew member, so this is only a suggestion.

Nevertheless, the findings support theory of standardization that standards have to be meaningful for workers to function as intended. I will now further develop argumentation about the necessity for standards being seen as meaningful in order to be implemented as intended when I in the next chapter discuss an incident and the aftermaths of this incident that happened six months prior to my trip.

6.0 The boiler incident

Approximately 6 months prior to my trip there had been a severe incident concerning one of the ship's two main boilers, when it had an inside explosion. Luckily, one of the crew members was able to turn on the emergency stop, before the explosion expanded, preventing a possible fatal outcome.

The boiler incident is a very sensitive area, involving a lot of actors, many of them with economic motives. The insurance settlement is when I am writing this still not finished, and

this thesis is based on what I was told was written in the preliminary accident report. My findings are based on conversations with the crew. I will however emphasize that I found it challenging to discuss this topic while I was on board. The central office was as stated not too fond of me being on board, and messing around in such an investigation is probably something they were concerned about.

I will now try to show how this incident is an example of some of the shortcomings of the technical risk approach. I will also try to show different cultural values influenced the investigation after the incident. Because of having only one functioning boiler, the oil company the ship was working for demanded an SJA/RA to be filled out whenever going to shore. With these, I was able to see how standardized risk assessment was dealt with in practice, and how different approaches to risk can cause challenges for standardized schemes. How these schemes were treated gave a good insight to see the limitation of audits and also challenges for the constructivist approach to risk when doing risk assessment. But first, I will give a description of what actually happened.

6.1 How the incident occurred

A boiler is a closed vessel where water or other liquid is heated, steam or vapor is generated, steam is superheated, or any combination of these functions is accomplished under pressure or vacuum for use external to itself by the direct application of energy from the combustion of fuels, from electricity, or solar energy (Malek 2007: 1).

In this particular boiler, sea water is taken up and goes through a distillation and cleaning process, where the water is cleaned and the salt is removed, and thus ready to be used as freshwater. On a ship with the size of 300000 tons, a lot of heated water is needed for mainly two purposes: to heat up bunkers so that the oil reaches acceptable temperatures for

functioning on the engine, and during tank cleaning operations where seawater is heated up and used. The boiler basically functions as a coffee pot. Water is heated in large tanks, where heavy oil is used as fuel. With temperatures around 600-700 degrees Celsius, water is heated up to steam reaching 200 degrees Celsius. Bunkers that are used as fuel on the engines need to have a temperature on at least 140 degrees to work. If the temperature falls below that level, the bunkers turn to asphalt, something which should not happen as the engine then get damaged. The engine needs fuel at all times, subsequently the boilers are always running.

A boiler has to be certified by a classification company to be allowed to operate. Certification is normally done together with the classification process of the ship. The ship was not up for classification before 2010, and the boiler would therefore not be subject to a thorough inspection until then.

The boiler incident was first noticed when one of the engineers heard an unfamiliar sound from one of the engine's two boilers while he was working in the engine room. When he went to see what the sound was, he discovered that there was an inside explosion going on. Steam, which is normally in the upper part of the boiler, had come down in the internal-combustion engine. When this happens the effect on the engine increases rapidly, in this case to an estimated 40 bar on an engine that not are built to handle any more than 13 bar. This caused the inside explosion. To give an example on how great the effect was, paint on the ship's chimney 20 meters above the boiler melted and the boiler was almost ripped in two.

Ever since the incident, the crew together with a boiler specialist from another company had rebuilt and tested the damaged boiler. For an oil product tanker, having only one functioning boiler this is highly problematic. First of all, one has to rely completely on the one boiler that is functioning. The functioning boiler was the same type of boiler as the one which exploded, and it was therefore in a sense no reason to trust it more than the other one. When talking to a

couple of the crewmembers, they explained that they actually were surprised that it was not the other boiler that exploded. They thought it was in even worse shape than the other one, and they were thus not comfortable with having to rely on it. Secondly, the effect on heating up water is smaller. This increases time spent on tank cleaning operations because one is not able to heat up the amount of water as normal. To get a new functioning boiler was therefore of importance.

The rebuilding of the boiler finished during my stay. When it was finished, a man from the classification company came on board for the re-certification. One of the engineers and the boiler guy ran the required tests, while the man from the classification company took notes. After a few hours of testing, the boiler was considered to comply with the given standards, and was re-certified and ready to be taken into use. Because of the heavy noise in the engine room, and of course that they were focused on their job, I was not able to speak with the engineers during the testing. After the testing was finished however, they explained to me that the tests focused on the testing that the boilers limits were according to requirements for certification.

I asked quite a lot about what the crew felt about the position the classification company had when it came to controlling the ship, both in casual conversations and formal interviews. The answers gave an indication that the classification company had a quite high standing among the different crew members. The extensive tests they did when classifying a ship was something that impressed them. Also, when they were finished with the testing, there was no doubt that they believed the boiler was in good shape. Cooperation between engineers from the classification company and the crew was also seemingly good. They depended on each other and mistrust was seemingly not an issue.

After the incident, the company started to investigate what happened, with investigators from the central office. Their experts concluded that there had been an oil leak in the boiler. When oil leaks, it lays as an isolating layer on the steal. For the water to reach the same temperatures as normal, the engine needs higher temperatures. In this particular case 1000 degrees Celsius, 300-400 degrees more than normal thus the extreme rise in effect, causing the explosion.

The engineers who were operating the boiler were not included in the investigation group. They were questioned about what happened, and needed to show different log books to prove that everything was done according to the manuals, but nothing besides this. To say that the engineers on board were eager to talk about the incident would be an exaggeration, but it does not mean that they had an opinion about what had happened. I got an impression after talking to different crew members that they were not all sure that it was an oil leak that caused the explosion. First, they had not found that much oil inside the boiler. Some thought too little too claim that it was oil that caused the rapid increased heating. Secondly, the oil that was found was lubricating oil. To have an oil leak in a boiler is quite rare, but when it happens, it is often a leak from the boilers fuel tank. So they should have found heavy oil, not lubricating oil. This is scientific reasoning about what caused the accident, and could have been valuable for finding out what really happened. Even though they did not believe the conclusion from the investigation, they did not have alternative explanations, only questioning the report from the company.

I will argue that there two main reasons for the engineers not doing further investigations and trying to get their voice heard. First of all, this was the first major incident on board the ship, and the consequences were relatively small. No one got injured, and even though the only had one functioning boiler, they were going to get a new one. The consequences after the first Windscale accident were also relatively small for the sheep farmers, and it was not until after the Chernobyl accident the mistrust towards the scientist was clear. The reactions from the

crew were similar to the farmers in Cumbria. The Cumbrian sheep farmers did their own research after the Chernobyl accident, confirming their assumptions after the Windscale accident. The two incidents are thus similar.

The second reason was possible negative outcomes of the investigation. As I mentioned in the introduction to this chapter, there was an insurance question in this case. If the result of the investigation would show that the incident came as a result of for example not sufficient maintenance, there would be no insurance money, which could be an economic disaster for the company. The engineers were dependent that the insurance case would be solved in order to keep their jobs. They might also have felt solidarity towards the other crew members just as the farmers in Cumbria recognized solidarity and dependency towards the Sellafield plant (Wynne 1992: 299). The engineers chose therefore to let the reasons for the accident go. As one engineer said *"the thing that is important, is to have two functioning boilers. Let the other (companies) discuss the rest (insurance)".*

In the theory chapter, I argued that one of the weaknesses against the technical risk approach are that it has problems when predicting complex systems and modeling human-machine relationship. The boiler incident is in my opinion a good example of this. According to the audit schedule, with normal maintenance the boiler should have worked fine until 2010, but it did not. There were neither problems with the other boiler, which was identical with the one which exploded, and going through the same maintenance. To give a good reason for why it was this particular boiler which exploded is in my opinion impossible. Nevertheless, it clearly show challenges for the technical risk approach.

6.2 Compliance with the SJA/RA

One of the conclusions after the M/S Star was that the Accident Investigation Board understood that an audit would not necessarily identify non-conformities between an

established procedure and actual work practice. They do not however discuss why this is difficult. I indicated in chapter five that the SJA/RA that with the difference between the crew and the manuals in the approach to, the standard risk assessment is likely not to be seen as meaningful and thus not implemented according to the written procedures.

In addition to shipping company, insurers and the crew, there was a fourth actor which was involved in the boiler incident. The oil company the ship was working for was worried about how well the ship would work with only one functioning boiler. They demanded a SJA/RA to be filled out, whenever the ship went into a new port, which was the reason the schemes were filled out.

As explained, because the ship was an oil product tanker, it was often in shore. During my trip it visited 5 different ports, which is relatively speaking quite many for an oil tanker for such a short period of time. The SJA/RA was filled out by the chief engineer and him only. The rest of the engineers were not involved in the writing. This does not comply with how the SJA/RA was supposed to be done, as it is *a formal work group risk assessment exercise documented on a form.* I will not claim that the rest of the engineers were not included at all, as conversations about the boiler's condition were normal. But this cannot be regarded as a formal work group, and is therefore the risk assessment was not according to the manuals.

In the previous chapter, I explained how the crew members had a different approach to risk than the manuals, and how this posed challenges for the standardized risk assessment. What this resulted in was that they did not do risk assessment according to the written procedures. In this case however, the oil company would check if the SJA/RA was done so they had to fill the scheme. This was "solved" with letting the chief engineer doing all the paperwork. The documenting of the SJA/RA was thus in a way in compliance with the manuals. The paper work was done and ready to be inspected. It would be therefore difficult for an auditor to

check whether or not the rules actually were followed. The auditing focuses as Power suggested more on the system for control than what was actually being done. The way the audits are organized does not comply with what actually happens. This case gives therefore support Power's question whether an organization can be *loosely coupled to their organizational environments as mere 'rituals of inspections' (Power 1999:89).* They organize thus their work for getting audited, and the audits are not able to reveal whether or not there is compliance to written procedures, and could why the accident investigation board after the M/S Star Java accident commented on that an audit not necessarily is able to reveal compliance to written procedures.

The fact that it was only one person who filled out the forms, also underlines the question Renn asks about whose risk perception should count, because aggregating them is almost impossible (Renn 2008: 21-22).

6.3 Checklists

The safety manuals were not the only standardized schemes on board. I have already described my first meeting with a checklist, when taking the safety course. In addition to this, there were several other checklists and log keeping items the crew had to fill out. Two examples of these were the pre-arrival and the pre-departure checklist, checklists which I will explain functioned in a quite different way than the safety manuals.

The pre-arrival and the pre-departure checklists, had, as the name indicates, to be filled out before entering or leaving a port. On these checklists the responsible crew member had to tick out items that were to be checked. Such items were for example that the emergency power supply had to be in stand-by mode, visual inspection of steering gear, necessary auxiliary machinery was running, important pressures and temperatures are checked and standby

machinery was set in standby position (see appendix for a copy of the pre-departure checklist).

As an outsider, the checklist seemed quite extensive. The pre-arrival checklist had for example 12 items to be checked, which all had to be ticked out before entering a port. They were all supposed to be filled out before leaving or entering a port, and should be subject to a visual inspection every time the list was filled out. In reality however, the items were not explicitly checked. The lists were often filled out after the ship had entered or left the port. I asked why this was not done according to written procedures. The answers I got were that the engineers did not feel it was necessary to do "by the book". Many of the items, for example temperatures, emergency power supply etc, were always visible in the engine control room. If there were items that were not in correct mode, they would notice it, and correct it right away. That said, when they first started working on the ship, the checklists were quite helpful. They were used, but when they became routine, they were not used in the initial intended way. In other words, the checklists were not seen as unnecessary. The crew agreed that it was important that all these items should be checked. However, once they had been working with the lists for a while, they adapted their own way of controlling the items that were to be checked. The used it not exactly as intended, but more as a framework for structuring what they were supposed to do. This case is much the same as for the Dutch health workers I mentioned in the theory chapter. When the standardized lists are seen as meaningful, people will adapt them into their work practices.

6.4 Co-production of knowledge

The boiler incident was a severe incident. However the consequences of the incident could have been different if it had not been detected by any of the crew members. If he had not, the

explosion would probably have been greater, causing much more harm to the ship and possibly also to the crew members on board.

We will probably never know what actually caused the accident. However, we do know that the outcome of the investigation could have been different if there were other groups of people involved, and also if the impact had been greater. I doubt that the crew members would have held such a low profile about what caused the incident if someone had for example lost their life. I will claim that the aftermaths of the Chernobyl accident in Cumbria is an example of this. The consequences after the first Windscale accident were seemingly not to harmful, so the farmers kept quiet even though they felt that something was "not right". After the Chernobyl accident, the consequences were much more severe, which lead the farmers doing their own investigation questioning the scientific evidence from the government. This could also have been the result after the boiler incident had the incident been more severe. Luckily, we will never know.

Nevertheless, the incident shows that it is impossible to judge the boiler incident without including cultural values from the actors that investigated the incident. Latour has stated that there is nothing natural about forms of evidence. Evidence is always relative to the rules of acceptance for particular communities (Power 1999: 69). One cannot discuss science while excluding society, and vice versa. With this science and society is *co-produced* each underwriting the other's existence (Jasanoff 2004: 17). It could be argued that the boiler incident is an example of this. To avoid social or techno scientific determinism is important to get a better understanding of the relationship between society and technology. The co-production can shed light on how the relationship between the crew and the technology is on board the ship (Jasanoff 2004: 22).

I have no reason to argue that there is a right or wrong in this particular case, but I will claim that with involvement of the engineers in the investigation could have given other answers than the preliminary report suggested.

7.0 Conclusion

One and a half month after I left the ship, I returned once again to the oil refinery where I had started my trip. The ship was at shore, so it was possible for me to spend a day visiting the crew once again.

Down in the engine room one of the engineers told me that he had been inspired by my trip, and decided to use the manual for the crane in the engine room before use. He told me the first question in the manual had been whether he had conducted a SJA/RA. He laughed and told me that the question had put an end to him using the manual for the crane, not wanting to get involved with those assessment tools. Another engineer supplied with telling that he never used the risk manuals when he used the crane.

The conversation I had with the two engineers is quite descriptive for one the general findings in this thesis. In the beginning of this thesis, I asked the question *how dos different approaches to risk in the shipping industry affect how the Safety Management System is dealt with in practice on board ships.* Through observation of the crew and interviews with different crew members I found that the actual work practice when doing risk assessment do not match the written procedures.

The crew did not often conduct a SJA/RA, but when conducted one, they had other ways of doing it than as described in the SMS. I also found out that the crew in general has a different approach to risk than the SMS manuals. While the manuals are probability based, the crew members relate much more to hazards and signal value after accidents.

I have with this tried to explain the challenges standardization can face when they are not seen as relevant from the workers. I have in argued that the reason the SJA/RA was not implemented, it is because it is not seen as relevant for the workers. I have also tried to show that the audits done on these operations are not structured in the way that they are able to detect compliance or non-compliance to written work procedures. This is probably what the accident investigation board had in mind after the M/S Star Java accident This does not mean that standards cannot be meaningful at all. The pre-arrival and the pre-departure check-lists were found quite helpful, and were used as framework for structuring work. They were not used exactly as intended, but because they the matched their daily work practices they were helpful for structuring work.

Hazard characterization and signal value after an accident was influencing the crew members approach to risk and are part of the crew member's cultural values and background, and are important to take into consideration in the crew members approach to risk. The value of this is emphasized in M/S Star Java accident report as it mentions the lack of previous incidents with the crane as one of the reasons for the accident.

Different approaches to risk do not necessarily mean different opinions. As I explained in chapter 4 about critical operations on board, there was to a certain extent correlation with the manual's and the crew's opinion. The reason of the correlation might be shared experiences from the past, but that would have to be subject to another thesis.

I have tried to exemplify with the boiler incident that cultural values and background have an impact when doing scientific research. If crew members had been included in the investigation, the conclusion of what caused the accident could have been different. In this case they used their experience for finding scientific evidence. With this, science and society can said to be, in Jasanoff's words, *co-produced*.

There is no reason to say that cultural values are of less importance when judging risk. As we have seen, engineers from the boiler company were not able to make models that could predict the breakdown of the boiler. They were however, not able to do a correct prediction. If risk was something totally objective and measurable, perhaps they would have been able to it. I have also shown how the risk matrix is close to the economic approach to risk, taking for granted that risk is something measurable and objective. But as I have showed, objectivity is something difficult to obtain. The accident report after the M/S Star Java accident clearly states that it could be a factor for preventing accidents, giving support for the importance of experience.

With accepting that science and society are co produced, one has to have another way of assessing risk. The AIB after the M/S Star Java accident emphasize the importance of doing a risk assessment and implement necessary measures for insuring safety based on the assessment. I have no reason to say that this is not a good suggestion. However, after exploring the differences in the approach to risk within the shipping industry, I have revealed challenges when the lay people relate to risk through the "expert" founded safety manuals.

Even though the manuals were not consciously implemented, it did not mean that the crew was not concerned about safety. The situation was quite the contrary, risk limitation was embedded when they planned work, but it was based on previous experiences and not the standardized risk assessment procedures. I have earlier stated that there are correlation between what the crew regarded as critical operations and what was specified in the manuals. This means that different risk approaches does necessarily means that actors have different opinions about what is regarded as critical risky. As we have seen, what was characterized as critical operations in the manuals was also often regarded as critical by the crew.

I have not said anything about whether I think it is a good thing or not, that the crew does not use the SMS manuals as intended. Other people can judge that. But if I was to give an advice to the company on how to implement the SMS, I would suggest that to speak a language the crew would understand could be a way for reducing risks. I was once told by the HR-manager for an international aluminum company, that every time a person in the company lost his/her life in a work situation, his company had flag on half mast on all their facilities around the world. The reason was to the signal value, and the workers were thus reminded of taking safety measures. It focused as translation for the more mathematically based risk approach the company had, something he thought were a good way of doing

An area for further research could be how the Safety Manuals System is developed. I have indicated that there are a lot of actors involved in this process. One group missing in the development is the actual workers on board ships. The development process of the SMS is today black boxed. Research on this area could provide helpful information on how to better the implementation of manuals on board ships.

I started in this thesis with a short summary of the M/S Star Java. I have not tried to give any suggestion on how to avoid accidents. Hopefully though, I have been able to show characteristics of what influence crew members actions on board a ship. I hope this can be a contribution for understanding why these accidents happen.

8.0 Appendix

Doc no.; 9 Rev. no.; 1	[redacted] SHIP MANAGEMENT AS ENINGE – PRE-DEPARTURE CHECKLIST	

No.	Items to be checked	Tick out
1.	All necessary auxiliary machinery is running – standby auxiliary engine(s) is activated	_____
2.	All standby machinery, including pumps, is set to standby position.	_____
3.	Emergency power supply in standby mode	_____
4.	Starting air compressor is checked, main valve open and in "AUTO" mode	_____
5.	The heavy fuel oil viscosity is adjusted / controlled	_____
6.	Important pressures and temperatures are checked	_____
7.	Steering gear room is checked, level in reservoir tanks checked.	_____
8.	Indicator valves is closed	_____
9.	**Communications;** Telephone; Steering flat / Bridge tested Telephone; Engine room / Bridge tested UHF radio tested	_____ _____ _____
10.	Remote control is transferred from engine control room to bridge **Make sure that bridge and engine control room manoeuvring handles are set to "STOP" position before change over switches is operated.**	_____

Port;	Date / Time;
Responsible officer confirmation of compliance;	Rank;

Distribution of checklist; Original in file in engine control room
Duration; 3 months

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