

**Teamwork as a Means to Safer Performance
in the Complex System of the Shipping Industry**

Anine-Catharina Martinsen Charlsen

Master's Degree in Work- and Organizational Psychology



Department of Psychology

University of Oslo

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Abstract

Teamwork as a part of the human factor is considered to be an important factor for safe performance in the shipping industry. The first aim of this study was to investigate how the domain specific CRM model and the domain independent Big Five in Teamwork Model (Big Five model) captured the reflections of three teams on different levels in the shipping industry as a complex sociotechnical system. The second aim was to examine these two models across the different levels. The study was carried out in a large ship owning company's organizational network, performing 39 SWOT based interviews on three levels: employees in ship management companies (the Core team), and the crew on board vessels divided into officers (the Top officers) and ratings (the Ratings). The results showed that in total, the CRM model captured 90% of the descriptive information gathered during the interviews, while the Big Five model captured 60%. The results of the analyses across the levels showed that the Ratings holds a significantly lower number of statements compared to both the Top officers and the Core team, whereas there is no such difference between the Top officers and the Core team. Nevertheless, there is no significant difference in the percentages of SWOT statements covered in the two models across the three levels, which indicates that the difference is due to the gap in reflection levels between the Ratings and the two other teams, and that the models are applicable to the same extent in all three levels.

Introduction

“To be a successful ship owning company we need to focus on quality and safety. It is impossible to only have a commercial success, without a very good reputation as a safe and high quality manager” (The Technical Manager, the Company, 2009).

This quotation is expressed in a short film that is part of the Company’s current safety campaign. This large ship owning company, from now on anonymized as the Company, yearly spends four to six million Norwegian kroner on this safety campaign. The overall goal is to raise awareness of the importance of the human factor in safety, and to make safety one of the primary concerns.

Safety in Complex Sociotechnical Systems

Today, safety and risk management is considered of high importance in a variety of industries. In the shipping industry, the accident statistics are quite low, compared to other industries (Hetherington, 2006). Nevertheless, it is an industry with a high potential for accidents and catastrophes. A ship is a part of a high-risk system, and even though the primary goal is to understand why accidents happen, and how to prevent them, it is important to acknowledge the fact that accidents are inevitable and even normal (Perrow, 1999). Risk will never be eliminated, and it is crucial to have this in mind, and remember that only imagination can limit the set of possible events which, in turn, may lead to an accident (Hollnagel, 2004).

Hollnagel (2004) describes system models and the relations between *the blunt end* and *the sharp end* in a system such as an organization (Hollnagel, 2004). The sharp end is the people who “actually interact with the hazardous process in their roles as pilots, physicians, space controllers, or power plant operators” (Woods, Johannesen, Cook, & Sarter, 1994, p. 20). The diverse behavior in the sharp end, and the errors made, are influenced by a variety of factors in the organization and the surrounding society. The corresponding blunt end consists of the people who influence safety “through their effect on the constraints and resources acting on the practitioners at the sharp end” (Woods et al., 1994, p. 20). When searching for causes of accidents one has to search in the complex network: the local workplace factors, the (local) management, the company, the regulating authorities, the government, and the social norms and morals. All of these factors influence each other. However, the definitions of the sharp and the blunt end are relative: Someone’s blunt end might be someone else’s sharp end

(Hollnagel, 2004). In the shipping industry, for example, the crew on board a vessel is a potential sharp end, while a ship management company, and a ship owning company, might constitute the blunt end.

The shipping industry is highly hierarchical. This is especially true on the vessels, where the captain and sometimes other senior officers are fully in charge (Perrow, 1999). There are distinct differences between the ranks, which not only defines work tasks, but also where a person sleeps, eats, and spends his spare time. The crew on board is isolated from the society for several months, for how long depends on the rank. During that period they function as each others colleagues, team members, and friends (Østreng, 2007).

The Human Factor

Human error. The human factor, in interaction with different levels and elements in the complex sociotechnical systems, is the key to both success and failure (Woods & Hollnagel, 2006). In the shipping industry, Perrow (1999) identified factors in this complex network which he argues induce errors: the structure of the industry, international regulations, economic pressure, and the social (hierarchical) organization on board the vessels (Perrow, 1999). The human factor is present in all the levels of the complex system and in that way, human error is a substantial contributor to the causal chain (Hetherington, 2006). Hetherington (2006) also claims that human factors influence safety in a number of ways: fatigue, automation, situational awareness, communication, decision making, health and stress, and teamwork. Numerous models have been proposed to define the interactions between the human factor and the different elements. The common denominator is the need to understand interactions between humans and the elements of the complex system (Bridger, 2003; Carayon, 2006).

Team errors. In complex systems, most of the human work is performed in teams (Sasou & Reason, 1999). The focus on team and teamwork in research has increased rapidly over the last three decades. This has happened as a natural consequence of the increased use of teams and teamwork in society (Guzzo & Dickson, 1996). When errors on group level happen, it is also important to consider human relations, and how these relations influence the errors happening in the group (Sasou & Reason, 1999). Sasou and Reason (1999) defined team errors as “human error made in group processes”. Teamwork has many potential advantages. For one thing, it is an important tool in detecting and rectifying errors. Teamwork is also a potential creator of error (Sasou & Reason, 1999). Inefficient and malfunctioning

teamwork may be a threat to safe performance (Salas, Burke, & Cannon-Bowers, 2000). A classical example is the concept of groupthink (Janis, 1972). Accident statistics, for example in the aviation industry, show that in most cases, the aircraft was mechanically capable of flying. It is the team, the crew, which is the root of most incidents and accidents happening (Hackman, 1993).

Teams and Teamwork

Many researchers state the importance of well-functioning teamwork in managing risk and error (e.g. Edmondson, 1996; Sexton, Thomas, & Helmreich, 2000; Wiener, Kanki, & Helmreich, 1993). Perrow (1999) stated that the shipping industry is itself an error-inducing system, because of its distinctive characteristics (i.e. the structure of the industry, international regulations, economic pressure, and the social (hierarchical) organization on board the vessels). The potential for change lies in the human relations, and in the importance of facilitating teamwork. Teamwork is a crucial factor in affecting safe performance. The crew should be trained to work as a team, and the equipment should be designed to maintain teamwork (Perrow, 1999). According to Perrow (1982, 1999) the key factors in teamwork that facilitates safety in the shipping industry are monitoring, speaking up when necessary, sharing and checking the team's mental models, and having a shared responsibility (Perrow, 1982, 1999). But what constitutes a team, and what is teamwork? In the literature an inconsistency in definitions and explanations of team and teamwork is evident (e.g. Guzzo & Dickson, 1996; Salas et al., 2000; Salas, Sims, & Burke, 2005). One of the most common definitions of a team is: "two or more individuals with specified roles interacting adaptively, interdependently, and dynamically toward a common and valued goal" (Salas, Dickinson, Converse, & Tannenbaum, 1992). In addition, a team is often characterized as having heterogeneous and distributed expertise (Salas, Stagl, Burke, & Goodwin, 2007). A team can also be a subgroup of a bigger team (Salas et al., 2000). Teamwork may be defined as "a set of interrelated thoughts, actions, and feelings of each team member that are needed to function as a team and that combine to facilitate coordinated, adaptive performance and task objectives resulting in value-added outcomes" (Salas, Sims, & Klein, 2004).

Team types. Teams are complex in nature, and there is a lack of consensus around the typology of teams. Cannon-Bowers and colleagues (1995) proposed "integrated teamwork skill dimensions", that is supposed to be common for all types of teams (see Cannon-Bowers, Tannenbaum, Salas, & Volpe, 1995; Salas et al., 2000). In general, previous research tends to

share this focus on teams: that there are factors common for all team types. This research does not distinguish between the different types of work that teams perform, and act as if one common model is applicable for all (Salas et al., 2000). However, there is reason to assume that there are different types of teams working within the same organization or in different organizations and domains. Sundstrom (1999) identified different team types based on the kind of work and tasks the teams are engaged in (see Sundstrom, 1999). In different team types, factors relevant for team performance will vary (Salas et al., 2000). Cannon-Bowers and colleagues (1995) also argued that there is a division between *team specific factors*, *team generic factors*, *task specific factors*, and *task generic factors*. Team and task generic factors are factors that can be applied across team types. Team and task specific factors, on the other hand, depend on team type characteristics and team members (Cannon-Bowers et al., 1995).

The Big Five in teamwork Model. Salas and colleagues (2005) conducted a review of the literature on team and teamwork of the past 20 years. As previously mentioned, in different organizations there are various types of tasks and teams. Nevertheless, they claimed that there are several common features that facilitate teamwork across domains, team goals, and tasks (Salas et al., 2005). Based on this review they derived *the Big Five in Teamwork Model* (Big Five model), a model that consists of five core components of teamwork and three coordinating mechanisms (eight components). The three coordinating mechanisms are necessary to get the optimal value of the core components.

The factors of teamwork in the Big Five model *are team leadership, mutual performance monitoring, backup behavior, adaptability and team orientation*. The coordinating mechanisms are *shared mental models, mutual trust, and closed-loop communication*. Some of these factors are very similar to the factors important for safe teamwork in the shipping industry proposed by Perrow (1982, 1999). The following are the definitions of the five factors in the Big Five model (Salas et al., 2005):

1. Team leadership: “The ability to direct and coordinate the activities of other team members, assess team performance, assign tasks, develop team knowledge, skills, and abilities, motivate team members, plan and organize, and establish a positive atmosphere”.
2. Mutual performance monitoring: “The ability to develop common understandings of the team environment and apply appropriate task strategies to accurately monitor teammate performance”.

3. Backup behavior: “The ability to anticipate other team members’ needs through accurate knowledge about their responsibilities. This includes the ability to shift workload among team members to achieve balance during high periods of workload or pressure”.
4. Adaptability: “The ability to adjust strategies based on information from the environment through the use of backup behavior and allocation of intrateam resources. Altering a course of action or team repertoire in response to changing conditions (internal or external)”.
5. Team orientation: “The propensity to take other’s behavior into account during group interaction and the belief in the importance of team goals over individual members’ goals”.

The definitions of the three coordinating mechanisms are as follows:

1. Shared mental models: “An organizing knowledge structure of the relationships among the task the team is engaged in and how the team members will interact”.
2. Mutual trust: “The shared belief that team members will perform their roles and protect the interests of their teammates”.
3. Closed-loop communication: “The exchange of information between a sender and a receiver irrespective of the medium”.

Salas et al. (2005) acknowledged that a team’s engagement in the factors and the coordinating mechanisms (components) will vary in different tasks as the teams get the experience of working together over time. Nevertheless, they proposed that the coordinating mechanisms will have minimal variance across team type or team task. Shared mental models are considered especially important in teams experiencing stressful conditions. (e.g. Salas, Cannon-Bowers, & Johnston, 1997). Also, communication is invaluable in teamwork, particularly in complex environments, such as emergency situations. However, this depends on the message being received and understood correctly, hence the coordinating mechanism of closed-loop communication (Salas et al., 2005).

There is a lack of research on the Big Five model and its suitability as a model applicable across domains. Kay, Maisonneuve, Yacef, and Reimann (2006) examined the Big Five model and visualizations of teamwork activity, and demonstrated that visualizations can express various aspects of the components of teamwork. However, they argued that it is

unlikely that a general optimal combination of values can be identified (Kay et al., 2006), as situational demands and the history of the team (e.g. how well the members know each other) are important aspects to take into consideration (Erickson, 2000). This implies that a so-called domain independent model such as the Big Five model is impossible to develop, as the human factors and the situation always are present.

Team and teamwork as human factors in the shipping industry is a central theme in the Company's safety campaign. An introduction to the Company's *QualitySafety Campaign*, its development and content, will be given below. The campaign also introduces a practical, domain specific alternative to the Big Five model.

The Company's QualitySafety Campaign

The Company's QualitySafety Campaign was released for the first time in 2002, stressing the influence of human factors in the management of error and safety performance, with the overall goal of having the safest fleet in the world. The concept of human factors was introduced on all the Company's vessels. After a decrease in accident and incident statistics between 2002 and 2005, there was a sudden increase in 2006. This resulted in a second release of the campaign, QualitySafety2 (QS2), in 2006. QS2 did not become as successful as the Company had hoped, and during 2009, the third release, QualitySafety3 (QS3) is being carried out. It consists of a "toolbox" for the vessels which contains guidelines for the captain on how to conduct a QS3 introductory meeting, instructions on how to perform individual computer based training, and guidelines for the implementation of safety meetings. Both the introductory meeting, and the safety meetings in particular, presents teams and teamwork as fundamental means to learning and performing work related tasks. From QS2 to QS3, an important change is that the ship management companies now have appointed safety coaches. Their task is to help implementing the tools in QS3 on board the vessels (i.e. instructions for introductory meeting, individual computer based training, and group discussions at the safety meeting), and to facilitate focus on the campaign and on safety thinking and performance in general.

The Company's QualitySafety Campaign is developed by external parties: A public relations company, a psychologist, and a flight captain. The content in the QualitySafety is founded on the principles of *the SHELL Model* and *Crew Resource Management (CRM)*. A brief introduction will be given below.

The SHELL Model. Human factors training evolved and established itself in the 1970's, to a considerable degree based on Edwards' SHELL Model: *software, hardware, environment, liveware* (Edwards, 1972). Later, Hawkins (1994) extended the model with another *liveware*, arguing that the interaction between the two *livewares* is crucial. The extended model, the SHELL Model, identifies elements of the individual, and the interactions between the individual and the surrounding system. The first *liveware* represents the human operator, the most flexible element. It is this *liveware* that constantly interface with the other elements. Hardware encompasses the physical tools, such as machines and instruments. Software is the non-physical aspects, for example procedures and checklists. The element environment is the adaptation to the environment, the equipment necessary for protection, such as helmets and glasses. The second *liveware* is the people, and the interface between the two *livewares* is the interaction between people. Further, Edwards (1975) examined the function of *liveware* and framed the Trans-Cockpit Authority Gradient (TAG). The concept states the importance of an optimal working relationship in the cockpit in an airplane, that the captain's authority should neither be over- nor underemphasized (Edwards, 1975). This is important to obtain the most favorable condition in order to perform safe flights. To a great extent, CRM principles are inspired by the factors and relations in the SHELL Model.

Crew Resource Management. CRM is the utilization of resources, human as well as material, to ensure safety and efficiency, originally developed to minimize incidents and accidents in the aviation industry (Wiener et al., 1993). Gradually, CRM has been adopted in many other industries as well, especially in high-risk industries, such as nuclear power plants, surgical theaters, and marine operations (O'Connor et al., 2008). Today, error is acknowledged as inevitable and normal, (see above, Perrow, 1999) called *error management*. CRM is a set of tools that can be used to avoid error, to trap incipient errors and hinder them from being committed, and in worst case, moderate the consequences of already committed errors (Helmreich, Merritt, & Wilhelm, 1999).

Studies reveal that attitudes towards basic CRM concepts decline with the years, even with recurrent training (e.g. Helmreich & Taggart, 1995). The main task for the safety coaches is to maintain these attitudes.

Team as the basic unit is the key to safe and well-functioning performance (Hackman, 1993). In QualitySafety conferences, a practical model is used as an educational tool. In this model, the Campaign's creators have systematized the basic CRM factors, to illustrate how

factors influence safe team performance on board the vessels. SHELL and TAG principles are also included in the factors. In this study, this model is referred to as the CRM model.

The CRM model. The primary function of the CRM model is to illustrate different factors that influence the crews' ability to enhance safety on board the vessels. Teamwork is an essential component, and an absolute requirement to perform safer operations. Several high-profile accidents in the aviation and shipping industry show that individual skills and competence alone is no guarantee for safety. In this model, there are seven factors that influence the team and its performance: *the individual, communication, culture, operational atmosphere, procedures, stress and workload, and sleep and fatigue*. In addition, there are three output factors that influence each other. The first is *shared situational awareness* which constitutes the foundation for the second, which is *decision making*. Correct decision making will result in the third, which is *safer and more efficient operations*. In the present study, the interest is primarily the factors that influence teamwork, and therefore, the three output factors will not be included in the analysis. In the next section, a brief description of the seven factors influencing team performance will follow.

1. The individual refers to individual characteristics such as personality, attitudes, and how the individual perceives the world, and the possibility for misinterpretation. Also, it includes the individual skills and knowledge possessed by an individual.
2. Communication has two interconnected aspects. The first acts as a physical means to accomplish tasks, including commands, stating intentions, and information. The second is how things are communicated (Kanki & Palmer, 1993). The aim is to obtain good performance and a safe crew. These are typified by behavioral markers such as speaking up, using clear language, listening, taking other's opinions seriously, and confirming messages.
3. Culture includes occupational, national, and organizational culture. It is important to have a shared organizational culture, particularly when the crew is multinational or multicultural.
4. Operational atmosphere is about the interaction and cooperation between team members. A healthy atmosphere exists when the relations inside the team are based on trust, well-being, and predictability, and when the leader facilitates these factors. As a result, the operational atmosphere will be characterized by informal, two-way communication.

5. Procedures are important in order to achieve safe and effective team performance, coordination of activities and tasks in a systematic, timely manner (Kanki & Palmer, 1993). Wiener (1993) confirms the need for the cockpit crew not only to get the proper documents, checklists, procedures, etc, but also the requirement for these to be adapted to crew needs, and the difference of standards in cockpits (Wiener, 1993).
6. Stress and workload includes everything that a person experiences as stressful, such as the job environment, interpersonal or personal affairs, and workload. Both a workload which is too heavy and a workload which is too light increase the risk for error and may influence safety.
7. Sleep and fatigue. Humans are totally dependent on rest and sleep, and when a person does not get enough rest and sleep, the judgment and coordinating mechanisms are weakened.

In QS3, different kinds of training cover all the seven factors in the CRM model. The introductory meeting and the safety meetings emphasize the team as the operational unit. The computer based training aims to train the individual. The content of the meetings cover the remaining six factors (i.e. communication, operational atmosphere, culture, procedures, stress and workload, and sleep and fatigue).

The sections of the QualitySafety Campaign and the CRM model are in agreement with both the originators and the Company itself.

The Company is part of a larger complex sociotechnical system, an organizational network where this study is carried out. The sections below give an introduction to this organizational network: what and who it consists of and how these elements on different levels relate to each other.

The Company as a Complex Sociotechnical System

The data in the present study was collected in an organizational network, and not in an isolated organization. This organizational network consists of the Company itself; their top management, the ship management companies, and the vessels. The Company is one of the world's largest private-owned tanker companies, with the top management located in Norway. The technical management and post fixture of the vessels are outsourced to several ship management companies situated around the world, which are responsible for the technical management and post fixture of the vessels on a daily basis. In the Company there are designated fleet managers who are responsible for one or several ship management

companies. In the ship management companies there are a number of people working with the Company. There are one or several fleet managers with the overall responsibility for the vessels belonging to the Company, and superintendents responsible for one or several vessels. The superintendents are those who communicate with the vessels on a regular basis on technical issues. They report to their fleet manager who again report to one of the fleet managers in the Company. The employees in the ship management company working with the Company (but not necessarily exclusively), will be referred to as the core team. The employees that form the core team are from different departments, covering technical matters, marine, personnel, safety, purchasing, and accounting.

On board the vessels, the ranks are divided into officers and ratings. The difference between officers and ratings is the requirement for different types and degrees of formal education and certifications. The officers possess the highest ranks on board, while the ratings hold the lowest ranks. There are approximately 23 crew members on each vessel, divided into deck department, engine department, and galley.

The top management on the vessel consists of the master, who has the overall responsibility of the vessel, the chief officer, the chief engineer, and the second engineer. This foursome is named as the top officers, and will subsequently be referred to as this. The top officers work closely together, as a management team. Each management company has a pool of these top officers, who are, as far as practically possible, appointed to sail only on vessels owned by the Company. Ratings have no similar pool, which to some extent would guarantee them to sail on vessels from one particular ship owning company. However, this happens quite frequently.

The communication between the vessel and the superintendent depends on the ship management company. In some of the companies the superintendent communicates exclusively with the master and the chief engineer, while in other companies some of the lower ranks also communicate with the superintendent.

The above sections about the Company and the organizational network are in agreement with the Company.

The Present Study

Reflections concerning teamwork may be considered an important aspect of daily work. The purpose of this study is to investigate to what extent these reflections in a complex sociotechnical system such as the Company's organizational network might be captured by domain specific or domain independent teamwork models. This is an industry with distinctive characteristics, compared to other industries and domains.

In addition, there are different levels within the industry. These levels differ considerably, and it is interesting to investigate whether different teamwork models are equally applicable on these levels. This complex system of the shipping industry may be divided into the blunt end (ship managers and ship owners) and the sharp end (vessel). Taken even further, the sharp end may be divided into officers and ratings. These three levels might hold teams that may qualify as different team types. The work tasks are highly different. The core teams work in regular offices with fixed working hours. The crew (i.e. officers and ratings) stays continuously on their workplace for months at a time and interacts with the same people day and night. Officers and ratings also differ in a number of ways. The most significant difference is that the top officers constitute the top layer and possess the highest ranks on board while the ratings hold the lowest ranks. When there are teams as different as these three teams, it is reasonable to wonder if teams on different levels also may show different levels of reflection.

In the present study, reflections concerning teamwork on these three levels are examined. In the present study, two of the ship management companies constitute the blunt end. The vessel as a whole constitutes the sharp end.

The team on shore, the blunt end (ship management companies), is coined *the Core team*. The two teams from the sharp end (the crew on board the vessel) are coined *the Top officers* and *the Ratings*. In this study the officers on board which are not among the top four are not included.

In order to sample reflections from this complex system addressed above, interviews structured within a SWOT format was considered preferable. SWOT is an acronym for *strengths, weaknesses, opportunities, and threats*. The SWOT Model attempts to capture reflections concerning present strengths and weaknesses in an organization, as well as reflections concerning future opportunities and threats in the surrounding environment

(Dyson, 2004). Traditionally, this kind of analysis is used in strategic planning (Mintzberg, 1994). Recently, the Model Driven SWOT (M-SWOT) has been introduced as a tool in organizational development. The M-SWOT is a method whereby SWOT statements are coded into, and matched with, already existing research-based models in a specific field (Hoff et al., 2009). This was desirable for the present study, and the rationale behind the choice of SWOT as the interview format. The observed and SWOT coded reflections (SWOT statements) will also be coded in the two models of interest, which are the domain independent Big Five model and the domain specific CRM model.

Hypotheses

1. In research, there is a dissension whether there are common factors for effective team performance applicable to all industries, or whether different team types (within or across industries and organizations) require tailored models. Because of these contrasting beliefs it is of interest to ask: Will it be a significant difference in the number of SWOT statements that may be coded in the domain independent Big Five model, and the domain specific (practical and tailored) CRM model?
2. The teams are in different levels in the complex system: The Core team is in the blunt end and the Top officers and the Ratings in the sharp end. Another way of investigating the applicability of the Big Five model is to examine the model across levels in the same complex system. If the Big Five model is applicable within domains, no significant differences in number of SWOT coded statements across the levels are expected, neither in the total number of statements, nor within the eight Big Five model components.
3. The CRM model is originally meant to illuminate the specific factors important to teamwork on board a vessel. Therefore, the Top officers and Ratings are expected to show a significantly higher level of reflection (a higher number of statements) in the CRM model than the Core team.

Method

Participants

In total, 39 participants were interviewed on three different levels in the organizational network of the complex system. The first aim was to capture reflections about team and

teamwork among people in the organizational network, and the second was to unveil the reflections in different teams at different levels in this complex system. Three teams were defined. As mentioned earlier, the first team was the employees in management companies dealing particularly with the Company on a day-to-day basis, called the Core team. The Core team in two management companies was interviewed, resulting in 16 interviews in total. The other team was the Top officers on board a vessel, with 11 interviews in total. The third team was the Ratings, where 12 interviews were carried out.

All the interviewees were male. The average age was 43 years old, ranging from 23 to 61. Regarding nationality, 26 participants were from India, 6 from Croatia, 2 from Britain, 2 from Pakistan, 1 from China, 1 from Malaysia, and 1 from Russia.

Measures

The aim of this project is to obtain the interviewees' own reflections about team and teamwork in their job environment. Therefore, a semi-structured interview format was the most desirable alternative. For the interviewer, a semi-structured format implies predefining topics or questions in an interview guide (see Appendix A), but at the same time being flexible, and let the interviewee talk freely about the topic and other topics that may appear during the interview (Payne, 2000).

The interviews are structured within a SWOT format. Thus, the interview guide consists of four main questions, one for each component (strengths, weaknesses, opportunities, threats): "*What do you think is positive when it comes to teamwork in your job environment?*", "*What do you think is negative when it comes to teamwork in your job environment?*", "*How could teamwork be even better?*", and "*What kind of problems could prevent teamwork?*". The questions are open, and in that way let the participants talk freely about what they think is important.

Procedure

Interviews. The interviews were carried out in the period from November 2008 to February 2009. The participants in the Core team in the two management companies were interviewed in their offices, one in Singapore and one in Dubai. The interviews of the Top officers were carried out partly in one of the management companies, on board a sailing vessel, and also at an officer's conference in Croatia, arranged by one of the two management

companies. The last team, the Ratings, was interviewed on board a vessel. The vessel, where both some of the top officers and all the ratings were interviewed, is operated by one of the two management companies in the sample. An important aspect was to get familiar with the crew before interviewing, in order to gain as much trust and honest reflections as possible. Therefore, the interviewers sailed with this particular vessel for ten days. The first interview was carried out on day five.

The location of an interview can be important. It is preferable to be in a quiet, private, and calm place, with as few interruptions as possible from the surrounding environment (Payne, 2000). The interviewers took this into consideration, and the interviews were conducted in quiet rooms such as conference rooms, small hotel suites, and a spare cabin. The interviews were carried out by one of the two Master's degree students, interviewing one interviewee at a time. Before the interviews were performed, the interviewees were asked to read an informed consent (i.e. the information letter, see Appendix B). The informed consent contained information about the project, a confirmation that the information is confidential and not traceable, and that they agreed to the use of tape recorder. Both the interviewer and the interviewee signed the informed consent. The interviewees also read definitions of team (Salas et al., 1992) and teamwork (Salas et al., 2004), in order to avoid any misunderstandings concerning what the interviewers meant by the two terms.

The interviewer tape recorded each interview, to get the most correct picture of what was being said, and to make sure that no information was missed.

Transcriptions. The recordings of the interviews were transcribed, word-for-word, by the same two students that conducted the interviews. All information was made anonymous. The interviewees' spoken English was varied, and was sometimes hard to understand. To ensure that the interviews were correctly transcribed, the two students crosschecked each other, transcribing parts of each others' interviews. No deviation was found.

Analysis

Coding. The transcriptions were transferred to NVivo 8, a computer program designed to analyze and quantify qualitative data. Statements related to the interviewees' experiences of team and teamwork were identified and drawn from the transcriptions. These statements were coded into the SWOT-categories strengths, weaknesses, opportunities, and threats. The

definition of a statement was: “The smallest meaningful unit that says something directly, or indirectly, about the interviewees’ experiences of team and teamwork in their job environment” (in accordance with Craig, 2009; Imset, 2008; Salvesen, 2008; Straumsheim, 2007). Some statements were repeated during the interview. Only if the statements were in different sections in the text, and in another context, they were coded several times. In addition, the statements were only coded in one of the four main categories, implying that a statement could not count both as a strength and an opportunity.

The second step was to code the SWOT statements into the Big Five model (Salas et al., 2005). Hoff et al. (2009) refer to this part of the process as M-SWOT. This means that each of the statements were coded into one of the eight components of the Big Five model, either as one of the five core factors, or as one of the three coordinating mechanisms. In addition, numerous statements did not fit into the Big Five model. These were coded into the category *not accounted for*.

The third step was to code the SWOT statements into the factors of the CRM model, in the same way as with the Big Five model.

The coding in the SWOT Model and in the Big Five model was performed by both students. The coding in the CRM model was performed by one of the students, due to illness.

Statistical analyses. The quantified statements were plotted into SPSS 16.0, in order to apply statistical tests. A paired-samples *t*-test was carried out to test hypothesis 1. To test hypothesis 2 and 3, a One-Way ANOVA and Dunnett’s T3 Post-Hoc tests were applied. The reason for the choice of tests was the lack of homogeneity of variance in the data set, which Dunnett’s T 3 Post-Hoc tests take into consideration.

Inter-rater reliability. The inter-rater reliability was not investigated. Unfortunately, because of illness, one of the two students has been prevented from finishing the study.

Ethical Considerations

Participation in the study was voluntary. The interviewers considered it as very important that the employees did not feel bound to participate.

Also, before the interview the participants were asked to read the informed consent. As mentioned earlier in the Method sections, the informed consent gives information about the interviewers, the purpose and content of the study, a confirmation that all the data is

confidential and that the participants are assured complete anonymity, and an explanation of why it is preferable to tape record the interview. Both the interviewer and the interviewee signed the consent form.

Results

Descriptive Statistics

From the 39 interviews, 1900 SWOT statements were identified, distributed on the three levels: the Core team, the Top officers, and the Ratings. The distribution of statements in the SWOT Model is reported in Table 1. The Ratings holds the lowest number of statements, with 299 statements. The Top officers finds themselves in the middle, with 600 statements. The Core team holds the highest number of statements, with 1001 statements. Table 1 also shows that all three teams share the same distribution pattern. In total, strengths possess a superior share of the statements, with 1004 statements (52.84%), then weaknesses, with 475 statements (25.00%), opportunities, with 266 statements (14.00%), and threats, with 155 statements (8.16%).

Table 1

Distribution of statements in the SWOT Model, by teams

| SWOT | R | | TO | | CT | | Total | |
|-------|-----|-------|-----|-------|------|-------|-------|--------|
| | No. | % | No. | % | No. | % | No. | % |
| S | 204 | 68.23 | 325 | 54.17 | 475 | 47.45 | 1004 | 52.84 |
| W | 44 | 14.72 | 169 | 28.17 | 262 | 26.17 | 475 | 25.00 |
| O | 31 | 10.37 | 57 | 9.50 | 178 | 17.78 | 266 | 14.00 |
| T | 20 | 6.69 | 49 | 8.17 | 86 | 8.59 | 155 | 8.16 |
| Total | 299 | | 600 | | 1001 | | 1900 | 100.00 |

Note: R=Ratings, TO=Top officers, CT=Core team, %=Column percent, SWOT=SWOT Model, S=Strengths, W=Weaknesses, O=Opportunities, T=Threats

Of the 1900 SWOT statements, 1144 SWOT statements (60.21%) were accounted for in the Big Five model, distributed on the three teams, (cf. Table 2. For the Ratings, 158 of the 299 SWOT statements (52.84%) were covered in the Big Five model. For the Top officers, 389 of the 600 SWOT statements (64.83%) were covered, and for the Core team, 597 of the 1001 SWOT statements (59.64%) were covered in the model. The dispersion of statements on the five factors and the three coordinating mechanisms are not identical across the teams, but the three components holding most of the statements are common. These three are team orientation, with 498 statements in total (26.21%), team leadership, with 395 statements in total (20.79%), and backup behavior, with 97 statements in total (5.10%). Team orientation and team leadership is clearly the two most frequent components, possessing 47% of the statements alone. It is also worth mentioning that the coordinating mechanism shared mental models do not have any statements in two of the three teams (the Ratings, and the Top officers). In addition, there are 756 statements (39.79%) in the category not accounted for, the Ratings with 141 of the 299 SWOT statements (47.16%), the Top officers with 211 of the 600 SWOT statements (35.17%), and the Core team with 404 of the 1001 SWOT statements (40.36%).

Table 2

Distribution of statements in the Big Five model, by teams

| BF | R | | TO | | CT | | Total | |
|-------|-----|-------|-----|-------|------|-------|-------|--------|
| | No. | % | No. | % | No. | % | No. | % |
| TL | 50 | 16.72 | 192 | 32.00 | 153 | 15.28 | 395 | 20.79 |
| MPM | 12 | 4.01 | 6 | 1.00 | 12 | 1.20 | 30 | 1.58 |
| BB | 24 | 8.03 | 25 | 4.17 | 48 | 4.80 | 97 | 5.10 |
| A | 3 | 1.00 | 19 | 3.17 | 53 | 5.29 | 75 | 3.95 |
| TOR | 63 | 21.07 | 124 | 20.67 | 311 | 31.07 | 498 | 26.21 |
| SMM | 0 | .00 | 0 | .00 | 3 | .30 | 3 | .16 |
| MT | 4 | 1.34 | 20 | 3.33 | 12 | 1.20 | 36 | 1.90 |
| CLC | 2 | .67 | 3 | .50 | 5 | .50 | 10 | .53 |
| Sum | 158 | 52.84 | 389 | 64.83 | 597 | 59.64 | 1144 | 60.21 |
| NAF | 141 | 47.16 | 211 | 35.17 | 404 | 40.36 | 756 | 39.79 |
| Total | 299 | | 600 | | 1001 | | 1900 | 100.00 |

Note: R=Ratings, TO=Top officers, CT=Core team, %=Column percent, BF=Big Five model, TL=Team leadership, MPM=Mutual performance monitoring, BB=Backup behavior, A=Adaptability, TOR=Team orientation, SMM=Shared mental models, MT=Mutual trust, CLC=Closed loop communication, NAF=Not accounted for

In the CRM model, 1710 SWOT statements (90.00%) were accounted for, distributed on the three levels (cf. Table 3). For the Ratings, 274 of the 299 SWOT statements (91.64%) were covered, for the Top officers, 547 of the 600 SWOT statements (91.17%) were covered, and for the Core team 889 of the 1001 SWOT statements (88.81%) were covered in the CRM model. The dispersion on the seven factors varies across the team in the different levels. As in the Big Five model, the three factors holding most statements are common. The three factors are operational atmosphere, with 578 statements (30.42%), communication, with 371 statements (19.53%), and stress and workload, with 335 statements (17.63%). In the category not accounted for, there are 190 statements (10%): For the Ratings, 25 of the 299 SWOT

statements (8.36%), for the Top officers, 53 of the 600 SWOT statements (8.83%), and for the Core team, 112 of the 1001 SWOT statements (11.19%).

Table 3

Distribution of statements in the CRM model, by teams

| CRM | R | | TO | | CT | | Total | |
|-------|-----|-------|-----|-------|------|-------|-------|--------|
| | No. | % | No. | % | No. | % | No. | % |
| I | 23 | 7.69 | 65 | 10.83 | 109 | 10.89 | 197 | 10.37 |
| CO | 41 | 13.71 | 118 | 19.67 | 212 | 21.18 | 371 | 19.53 |
| CU | 34 | 11.37 | 45 | 7.50 | 80 | 7.80 | 159 | 8.37 |
| OA | 97 | 32.44 | 194 | 32.33 | 287 | 28.67 | 578 | 30.42 |
| P | 6 | 2.01 | 30 | 5.00 | 26 | 2.60 | 62 | 3.26 |
| SW | 70 | 23.41 | 91 | 15.17 | 174 | 17.38 | 335 | 17.63 |
| SF | 3 | 1.00 | 4 | .67 | 1 | .10 | 8 | .42 |
| Sum | 274 | 91.64 | 547 | 91.17 | 889 | 88.81 | 1710 | 90.00 |
| NAF | 25 | 8.36 | 53 | 8.83 | 112 | 11.19 | 190 | 10.00 |
| Total | 299 | | 600 | | 1001 | | 1900 | 100.00 |

Note: R=Ratings, TO=Top officers, CT=Core team, %=Column percent, CRM=CRM model, I=Individual, CO=Communication, CU=Culture, OA=Operational atmosphere, P=Procedures, SW=Stress and Workload, SF=Sleep and Fatigue, NAF=Not accounted for

Table 1, 2, and 3 show that neither the Big Five model nor the CRM model cover 100% of the SWOT statements. The Big Five model covers 60.21% of the 1900 SWOT statements. Distributed on the three teams, the Big Five model cover 158 (52.84) of the Ratings' SWOT statements, 389 (64.83%) of the Top officers' SWOT statements, and 597 (59.64%) of the Core team's SWOT statements. The CRM model covers 90.00% of the statements. Distributed on the three teams, the CRM model covers 274 (91.64%) of the Ratings' 299 SWOT statements, 547 (91.17%) of the Top officers' SWOT statements, and 889 (88.81%) of the Core team's SWOT statements.

Means and standard deviations for the three models on the three levels are presented in Table 4. The lowest means for all three models was observed in the Ratings team (SWOT: $M = 24.92$, $SD = 11.45$, BF: $M = 13.17$, $SD = 6.78$, CRM: $M = 22.83$, $SD = 10.97$). The Top officers is in the middle (SWOT: $M = 54.55$, $SD = 14.64$, BF: $M = 9.45$, $SD = 9.45$, CRM: $M = 49.73$, $SD = 12.04$), and the Core team possess the highest means (SWOT: $M = 62.56$, $SD = 15.55$, BF: $M = 37.31$, $SD = 12.36$, CRM: $M = 55.56$, $SD = 14.58$).

Table 4

Means and standard deviations in the SWOT Model, the Big Five model, and the CRM model, by teams

| | R | | TO | | CT | |
|------|-------|-------|-------|-------|-------|-------|
| | M | SD | M | SD | M | SD |
| SWOT | 24.92 | 11.45 | 54.55 | 14.64 | 62.56 | 15.55 |
| BF | 13.17 | 6.78 | 35.36 | 9.45 | 37.31 | 12.36 |
| CRM | 22.83 | 10.97 | 49.73 | 12.04 | 55.56 | 14.58 |

Note: R=Ratings, TO=Top offers, CT=Core team, SWOT=SWOT Model, BF=Big Five model, CRM=CRM model

Test of Hypotheses

Hypothesis 1 tested whether there would be a significant difference between the number of statements in the independent Big Five model, and the practical and tailored CRM model. This was examined by a paired-samples t -test. The result revealed that it was a significant difference between the two models ($M = -9.67$, $SD = 7.18$, $t = -4.67$, $p < .001$, cf. Table 5).

Table 5

Paired samples t-test for the Big Five model and the CRM model

| | M | SD | SE | t | df | Sig. |
|--------|-------|------|------|-------|------|------|
| BF/CRM | -9.67 | 7.18 | 2.07 | -4.67 | 11 | .001 |

Note: BF=Big Five model, CRM=CRM model

Hypothesis 2 predicts that if the Big Five model is applicable across domains, there will be no significant differences between the three teams in the total number of SWOT statements, or across the distribution of the components on the three teams. To test the difference in number of statements between the teams, a One-Way ANOVA was applied, with Dunnett's T3 Post Hoc tests to examine the significance between the different levels (cf. Table 6). The results did not support the hypothesis. There was a significant difference between the Ratings and the Top officers ($MD = 22.20$, $SE = 3.46$, $p = .000$), and between the Ratings and the Core team ($MD = 24.15$, $SE = 3.66$, $p = .000$). There was no significant difference between the Top officers and the Core team ($MD = 1.95$, $SE = 4.20$, $p = .954$). Further, it was of interest to examine whether there were significant differences between the components across the teams. However, this was not advantageous (or possible) because of the small, or non-existent, number of statements in several of the components (cf. Table 2).

Hypothesis 3 predicts that because the CRM model is meant for people on board the vessels, the Top officers and the Ratings will hold a significantly higher number of statements in the CRM Model, than the Core team. A One-Way ANOVA and Dunnett's T3 Post Hoc tests were applied. The results did not support the hypothesis (cf. Table 6), with significant differences between the Ratings and the Top officers ($MD = 26.89$, $SE = 4.81$, $p = .000$), and the Ratings and the Core team ($MD = 32.73$, $SE = 4.83$, $p = .000$). The difference between the Top officers and the Core team was not significant ($MD = 5.84$, $SE = 5.15$, $p = .597$).

Table 6

Post Hoc tests of number of SWOT statements in the Big Five model and the CRM model, by teams

| | Team | <i>MD</i> | <i>SE</i> | <i>df</i> | Sig. |
|-----|-------|-----------|-----------|-----------|------|
| BF | R/TO | 22.20 | 3.46 | 21 | .000 |
| | R/CT | 24.15 | 3.66 | 26 | .000 |
| | TO/CT | 1.95 | 4.20 | 25 | .954 |
| CRM | R/TO | 26.89 | 4.81 | 21 | .000 |
| | R/CT | 32.73 | 4.83 | 26 | .000 |
| | TO/CT | 5.84 | 5.15 | 25 | .597 |

Note: MD=Mean difference, R=Ratings, TO=Top officers, CT=Core team, SWOT=SWOT Model, BF=Big Five model, CRM=CRM model

To test hypotheses 2 and 3, it was also of interest to examine whether there in addition were significant differences between the three teams, not by the number of statements, but by the percentage of coverage of the SWOT statement in each team in the Big Five model and the CRM model. Dunnett's T3 Post Hoc tests were applied. The results are presented in Table 7. In the Big Five model, neither the Ratings and the Top officers ($MD = 11.44$, $SE = 6.42$, $p = .242$), the Ratings and the Core team ($MD = 5.16$, $SE = 6.10$, $p = .783$), nor the Top officers and the Core team ($MD = 6.28$, $SE = 4.22$, $p = .380$), showed significant differences. The Post Hoc tests of the pairs in the CRM model revealed the same pattern: no significant differences for the Ratings and the Top officers ($MD = .29$, $SE = 2.71$, $p = .999$), the Ratings and the Core team ($MD = 2.61$, $SE = 2.37$, $p = .619$), or the Top officers and the Core team ($MD = 2.90$, $SE = 2.38$, $p = .543$).

Table 7

Post Hoc tests of percentage of SWOT statements covered in the Big Five model and the CRM model, by teams

| | Team | <i>MD</i> | <i>SE</i> | <i>df</i> | Sig. |
|-----|-------|-----------|-----------|-----------|------|
| BF | R/TO | 11.44 | 6.42 | 21 | .242 |
| | R/CT | 5.16 | 6.10 | 26 | .783 |
| | TO/CT | 6.28 | 4.22 | 25 | .380 |
| CRM | R/TO | .29 | 2.71 | 21 | .999 |
| | R/CT | 2.61 | 2.37 | 26 | .619 |
| | TO/CT | 2.90 | 2.38 | 25 | .543 |

Note: MD=Mean difference, R=Ratings, TO=Top officers, CT=Core team, SWOT=SWOT Model, BF=Big Five model, CRM=CRM model

Discussion

The present study examined how well the domain independent Big Five model captured individual reflections in the organizational network as a complex sociotechnical system, compared to the domain specific CRM model. In hypothesis 1, the models were tested on the complex sociotechnical system as a whole, with no division between the different levels. In hypothesis 2 and 3, the models are tested across different teams in the different levels in the complex system, more specifically, across the Ratings, the Officers, and the Core team.

Domain Specific Models versus Domain Independent Models

The first finding, referring to hypothesis 1, revealed a significant difference between the Big Five model and the CRM model. The components in the Big Five model captured 1144 of the 1900 SWOT statements (60%), while the factors in the CRM model captured 1710 of the 1900 SWOT statements (90%). This indicates that the CRM model was an almost complete success in reflecting the participants' views. The Big Five model captured a fair

share. However, it may look like the CRM model gave a more complete picture of the reflections in this complex system.

The statements were distributed on all the eight components in the Big Five model, but there were big differences in how many statements each component contained. Also, one of the coordinating mechanisms, shared mental models, had no statements in two of the teams: the Ratings and the Top officers. Other than that, all the components were represented across the teams. One of the reasons for the big differences in the number of statements in the different components may be due to the size of the components. For example, team leadership includes more topics than mutual performance monitoring (Salas et al., 2005), which makes it only reasonable that team leadership has a higher number of statements than mutual performance monitoring. The varying size of the components may indicate that it is more favorable to look at and to compare the model as a whole. To divide the model into detached components and compare them, might give the wrong picture if the differences in size are not taken into consideration.

The size of the factors was as relevant for the CRM model as the size of the components were for the Big Five model. There were large differences in the size of the factors and how the statements were distributed, although all the factors were represented. Unlike the Big Five model, all the factors were captured in the CRM model, also across levels. However, this might implicate that it may be more favorable to see the model as a whole, in the same way as for the Big Five model.

One possible explanation for the deviation between the two models might be that a model which is claimed to be applicable across domains and industries is too specific. In other words, it may not include all the necessary components for being able to capture more than 60% of the reflections of team and teamwork in this complex system. This is in accordance with previous findings, which indicate that other components than the eight components in the Big Five model also influence teamwork and team performance, factors which are difficult to establish beforehand (Kay et al., 2006).

It is of interest to look into the statements that were not accounted for, to get a picture of what topics are missing in the Big Five model. More specifically, it would be useful to investigate if the topics are task or team generic, or task or team specific (Cannon-Bowers et al., 1995). If the topics are task or team specific, the notion of the Big Five model as too specific is supported. On the other hand, if the topics seem to be more team and task generic,

there is reason to assume that the Big Five model not only is too specific, but that the model also lack core factors which are crucial in teamwork.

The CRM model captured 90% of the total number of SWOT statements. Compared to the components in the Big Five model, the factors in the CRM model seemed to cover more topics. This means that some factors in the CRM model captured statements on more topics than the components in the Big Five model. Because of this, it is tempting to claim that in total, the CRM model captured more topics than the Big Five model. As mentioned in the introduction, both Hollnagel (2004) and Perrow (1999) cited several factors that influenced error and accidents. Hollnagel identified general factors in complex sociotechnical systems (i.e. the local workplace factors, the (local) management, the company, the regulating authorities, the government, and the social norms and morals). Perrow illuminated factors especially relevant in the shipping industry (i.e. the structure of the industry, international regulations, economic pressure, and the social (hierarchical) organization on board the vessels). These factors are interdependent factors, which interacts between different levels in the complex sociotechnical system. The factors themselves, and the size of the factors in the CRM model, were more in accordance with the assumption of seeing the whole complex system as important to take into consideration, than the Big Five model. In other words, the CRM model included more of the elements of the complex system than the Big Five model did. While the CRM model demonstrated the importance of seeing beyond the definite work tasks and work processes, these work tasks and work processes was the focus in the Big Five model.

The difference in coverage between the two models was 30%. This indicates that the CRM model might be more suited for this complex system of the shipping industry. The content in the factors were tailored to the industry, and have taken into account the characteristic job environment in which the seafarers work, which is reflected in the 90% coverage. This may signify that it might be more accurate to acknowledge that different team types may need models adapted to the specific domain in which the team works.

The Big Five Model Tested across Levels in the Complex Sociotechnical System

After exploring the two models in the shipping industry in the complex sociotechnical system as a whole, hypothesis 2 predicted that if the Big Five model were applicable within domains, there would be no significant differences, neither between the three levels nor in the

distribution of the factors and the coordinating mechanisms. The results showed that when testing the number of SWOT statements, there were significant differences both between the Ratings and the Top officers, and between the Ratings and the Core team. Unfortunately, some components had very few statements, so performing tests across teams and components were not advantageous or possible to perform. The outcome of the tests of the percentage of SWOT statements captured in the Big Five model, showed no significant differences between the three levels.

The results indicate that in this study, across levels in the complex sociotechnical system, there are definite differences in how various teams on various levels relate to the concept of team and teamwork. The differences between the teams and the difference across the factors might be due to differences in the reflection levels that vary across different teams and levels in the complex system, and not to a non-applicability of the Big Five model. More specifically, it is possible that the Ratings' reflection level, according to the Big Five model, is significantly lower than both the Top officers and the Core team. This will be more thoroughly looked into in later sections, to see these results in connection with the results of hypothesis 3, together with the total number of SWOT statements.

Further, if one looks in Table 2, there were components with a high number of statements, a low number of statements, and for shared mental models: no statements at all in two of the three teams. The isolated result that shared mental models had no statements both in the Ratings and in the Top officers might imply that the factor is not a crucial factor in teamwork on these levels. However, the Core team has a few statements in this component. More important, research suggests that the component shared mental models is an important component in teamwork, and especially important in teams experiencing stressful conditions (e.g. Mathieu, Goodwin, Heffner, Salas, & Cannon-Bowers, 2000; Salas et al., 1997). This signifies that the shared mental model and the other components in the Big Five model actually are applicable components in teamwork.

As mentioned earlier in the discussion, the Big Five model in total captured 60% of the SWOT statements. Split up into groups, the Ratings captured approximately 53%, the Top officers captured approximately 65%, and the Core team captured approximately 60%. These percentages were not significantly different, but they indicate that although the Big Five model contains core components of teamwork, it does not capture all aspects, at least not in this sample and the three subsamples. In addition, as mentioned before, the components were

of various sizes, and comparing them might be problematic without taking this into consideration.

The CRM Model Tested across Levels in the Complex Sociotechnical System

The CRM model is tailored to the shipping industry and more specifically to illuminate factors influencing teamwork on board the vessels. Hypothesis 3 predicted that because the CRM model is tailored to the crew, the Ratings and the Top officers, these two teams would hold a significantly higher number of statements in the CRM model than the Core team. The results did not support the hypothesis. There were significant differences in the number of statements between the Ratings and the Top officers, and between the Ratings and the Core team. Between the Top officers and the Core team, the difference was not significant. The tests of the percentage of SWOT statements covered in the CRM model, showed no significant differences between the three teams.

In total, the CRM model captured 90% of the SWOT statements, and captured the reflections in the organizational network to an almost complete extent. This signifies that the model is suitable for the three levels in this complex system and that the reason behind the differences might be found in the teams themselves and their reflection levels. This may be seen in accordance with the results of hypothesis 2, which revealed the same pattern: The Ratings held a significantly lower number of statements than both the Top officers and the Core team, while there were no significant difference between the Top officers and the Core team. The same pattern was evident when looking at the SWOT statements in total. This implies that there are distinct differences between the levels, and that the Ratings holds a lower number of statements on all three models. The fact that there were no significant differences between the teams in the percentage of the SWOT statements covered in both the Big Five model and the CRM model, indicates that the models are more or less applicable to the same extent across the three levels. This supports the assumption that the Ratings does not reflect around team and teamwork to the same extent as the two other teams.

The CRM model is adapted to the shipping industry, but especially to the vessels. One reason that the Core team on shore held a significantly higher number of statements than expected may be that although they are not sailing on vessels themselves, their work tasks are related to the vessel and to the industry. This makes them aware of what factors are important to safe performance on the vessels. In addition, the majority of the people in the Core Team are former seafarers, which may make them well aware of the life on board.

The top officers participate in conferences (e.g. QualitySafety conferences) that among other topics aim to illuminate the importance of human factors, and facilitate this kind of thinking and acting. In addition, they have completed many years of education. This may contribute to being more reflected about team and teamwork. Also, the top four officers constitute the top management on board the vessels, and they are working together in a clearly defined team, planning and administrating together. The core teams work together on matters related to the Company, but also with matters related to other ship owning companies. Despite this, they may also have a quite clearly defined team as well. In contrast, it is a possibility that the Ratings may not have the same clear team identity. Teamwork has been integrated in complex organizations as a necessary tool to obtain the best performance as possible (e.g. Sasou & Reason, 1999). It is possible that teamwork as a necessary tool is interpreted differently across the levels, that the Ratings has a different interpretation of what teamwork is. Their work tasks are mainly of a physical character, and for them, teamwork might be that one works together when the physical workload is too heavy. Also, compared to the two other teams, the Ratings may get more infrequent inputs on the importance of team and teamwork. For example, the QualitySafety Campaign is directed towards the vessels. Because ratings not necessarily stay on the Company's vessels for more than one contract, it is not guaranteed that they get this proactive input when they are sailing for other ship owning companies.

The Sharp End and the Blunt End in the Complex Sociotechnical System

Because of the marked division between the Ratings and the two other teams, it might be useful to evaluate the chosen division of teams in the sharp end and the blunt end. As mentioned introductorily, the definitions of sharp and blunt end are relative (Hollnagel, 2004). In the present study, a vessel as a whole is conceived as the sharp end and management companies as the blunt end. The results of the three hypotheses signify that independent of the models, there are differences in reflection level across the teams. The difference is between the two teams in the sharp end. This raises the question whether it would be more favorable to examine the teams as different team types, and define the sharp end as the Ratings, and both the Top officers and the Core team as constituting the blunt end.

Although the Top officers may fit into the definition of the sharp end, these four officers also form the management on board, with the responsibility for the administrative work. Perhaps the Top officers team has more common factors with the Core team, and may be the same team type, while the Ratings may belong to another team type. In this study, this

correction of what constitutes the sharp and the blunt end would result in a significant difference between the sharp end and the blunt end, which possibly would make more sense. It is of interest to further investigate the relativity of the sharp end the blunt end and what work tasks and team types they may and may not contain. It might be considered useful to assess the differences in knowledge, learning, and training, and perhaps discover how to optimize the methods to be as favorable as possible for the blunt end and the sharp end. This may in turn influence the performance and efficiency, and hopefully make the industry safer.

There are a number of possible explanations of the differences in the reflection levels across the models and across the three teams in the different levels. This study does not have the necessary foundation, nor is it the scope of this study, to conclude. What the results boil down to is that it is a significant difference between the Big Five model and the CRM model, with the CRM model capturing 30% more of the SWOT statements. This implies that the CRM model is better suited to capture reflections in the Company and its organizational network. Additionally, there are differences between the Ratings and the Top officers and between the Ratings and the Core team, in the number of statements, both on the SWOT model, the Big Five model, and the CRM model. If one looks at the percentage of SWOT statements covered in the two other models in each team, there are no significant differences. This indicates that the two models are equally adequate for the three teams, that the differences exists in the reflection levels, and not in how adequate the models fit the different teams.

In the present study there are several limitations worth mentioning, which may have influenced the results in one way or the other.

Limitations

Interviews. Performing interviews as a research method has both advantages and disadvantages. The main reason for conducting semi structured interviews and not using questionnaires was because of the sample: There were different persons in different levels in the complex system, and to send a standardized questionnaire was not considered fruitful. When interviewing, one has the opportunity to be flexible, and explain during the interview, if something is not clear for the interviewee. The students experienced this several times, most of the participants on all three levels asked several questions about the meaning of the interview questions. Also, the method is flexible in the way that it allows the interviewee to talk about topics he finds relevant (Payne, 2000). However, the interview as a research

method has one major disadvantage: the risk of not getting honest opinions. Because the interviewer and the interviewee are sitting face to face, this method may feel too personal, although the participants are assured complete anonymity and confidentiality before the interview. In addition, the interviewers may have been perceived as representatives from the Company itself, which in turn may have influenced the way the participants responded. It might be that the answers that are not one hundred percent honest, and this is important to take into consideration.

Another limitation with interviews as research method is that the interviewer may influence the interviews with wording, follow-up questions, body language etc. Also, when two interviewers are performing interviews, there is a risk that they have different ways of interviewing and different appearance, and in that way, get different information from the interviewees. In this study, to some extent, the interviewers asked different types of follow up questions. In addition, the age difference was 22 years, which might have influenced the interviews in the abovementioned ways.

The interviewers made several precautions to get the interviews as honest and unbiased as possible (see the Method sections). Nevertheless, when using interview as a research method, one can never be sure that one get the true reflections.

Sample. The participants' reflections might not be possible to generalize. The sample is quite big for a sample of interviews. Still, the statements extracted from the interviews were quantified, and when performing statistical analyses is 39 participants not a big sample. This makes the sample size vulnerable. For example, with a relatively small sample the differences have to be considerable to get significant differences (statistical power). In this study, there were significant differences between the Ratings and the Top officers and the Core team, but not between the Top officers and the Core team. A larger sample might have resulted in significant differences between these two teams as well.

It was impossible to get a random sample of ratings, top officers, and core team. The most important thing for the students was to get participants from levels in the same network in the complex system. This means that the two teams the Ratings and the Top officers were sampled from the employees of one of the two management companies where the core team was interviewed.

Also, there are many different nationalities and cultures in the complex system, which indicates that if the sample consisted of other nationalities and cultures, the results might have differed from the presented results. Nevertheless, the present study gives an impression of how seafarers and other employees in the shipping industry reflect around team and teamwork.

Another possible limitation is the ratings as one level in the organizational network. As mentioned earlier, the management companies have a pool with top officers which are appointed to sail on the Company's vessels. The ratings may have several contracts which appoint them to sail on vessels owned by the company, or they may only stay for one contract. This indicates that when interviewing ratings, and especially fresh arrivals, there will be a risk that they have very limited knowledge about the Company. This, in turn, may result in that their thoughts reflect their general experiences, and not only experiences in relation to the Company. According to Aubert and Arner (1962), this is a common way of reflection for seafarers. In their sociological study, they found that the crew they interviewed talked about their experiences in their career as seafarers, not at that particular vessel. This was consistent with the students' comprehension of the crews' reflections.

Coding. The coding of the interviews into the SWOT Model, the Big Five model, and the CRM model is complicated. It is a complex process which consists of several steps of interpretation, and a lot of information to process. It is of importance that the coding process is transparent and possible to replicate. The students were aware of this during the whole process, but still it was difficult to make the steps easy to replicate. The interviews are in English, and several participants had problems with expressing themselves in English. In addition, they used a lot of shipping related words and phrases, which make it difficult to understand the meaning if one has not been on a vessel and in that particular situation. The students took this into consideration, and spent a lot of time on this process, going through the steps several times.

Inter-rater reliability. The students intended to investigate the inter-rater reliability. Unfortunately, one of the students became prevented from completing the study, which happened before the inter-rater reliability was examined. The students were quite sure they became coordinated and relatively unanimous in the coding process. Nevertheless, there is a possibility that there were differences between the students which were not taken into consideration because of the absent inter-rater reliability test.

Quantification of qualitative statements. One challenge with the quantification of qualitative interview statements is to decide what counts as the weight of a statement. In the present study, each statement counted as one statement. All the statements had the same value. In other words, the students did not make allowance for the possibility that some statements are more important to a participant than other statements. This implies that one risks obtaining a more or less distorted picture of the distribution of statements. This may be a major limitation with the quantification of qualitative statements.

Future Research

This study has demonstrated that there is a significant difference between the Big Five model and the CRM model in the number of SWOT statements distributed on the models. This indicates that the domain specific CRM model is more suited to capture reflections in the shipping industry than the domain independent Big Five model. In the future it is necessary to examine the applicability of the Big Five model in order to validate the model. It would be interesting to differentiate between team types when investigating factors in teamwork, and examine the Big Five model across these team types.

As mentioned earlier in the discussion, it is important to further investigate the statements which are not accounted for, what topics they cover, and whether there are task and team generic factors, or task and team specific factors. To figure this out might help in getting a clearer picture of the applicability of the Big Five model.

The study showed that there are distinct differences in the number of statements between the three teams. It is of interest to further investigate these differences in the reflection levels. For the shipping industry in general, it should be desirable to increase the reflection level for all levels in the complex system. Increasing reflection level might influence the performance level, and lead to more safe and efficient performance. It is especially important to investigate the gap between ratings and other levels, when it comes to reflection levels on team and teamwork. The goal should be to find the key to why this gap exists, and try to develop tools to help even out the differences. It is necessary to find the factors that influence well-functioning teamwork to have teams perform as efficient and safe as possible. Studies of the human factor and teamwork are not very common in the shipping industry. It is important to increase the focus and studies on these factors.

The third phase of the QualitySafety Campaign (QS3) is being carried out as we speak. After some time, it is necessary to evaluate QS3, and investigate the effect of this type of proactive risk management.

Conclusion

In this study, the domain specific CRM model captured 90% of the SWOT statements, while the domain independent Big Five model captured 60% of the SWOT statements. This indicates that it might be favorable to use a domain specific teamwork model compared to a domain independent teamwork model to capture reflections in the complex sociotechnical system of the shipping industry.

Further, the results show that there are differences between the various levels in the complex system, and that both the Big Five model and the CRM model reveal differences between the teams. The Ratings differs in their reflections compared both to the Top officers and the Core team, indicating that the Ratings is not as reflected about team and teamwork as the two other levels. In addition, the study revealed no significant differences between the three teams in how well the Big Five model and the CRM model captured the SWOT statements. This supports the indication that differences in reflection levels across the teams are the reason behind the differences, and not the applicability of the models across the teams. The findings signalize the importance of facilitating teamwork especially for ratings in the complex system, in order to get ratings on the same level as other teams on other levels in the complex system.

Also, it might be more favorable to reconsider the definition of the sharp end and the blunt end, and define the sharp end as only the Ratings, and the blunt end as both the Core team and the Top officers.

The Technical Manager in the Company stated introductorily: “To be a successful ship owning company it is necessary to focus on quality and safety”. Human factors and teamwork are important aspects and an absolute premise for safety, something the Company has understood and proactively promotes. Now the shipping industry itself needs to follow this initiative in order to get a safer industry.

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Appendix A

Interview Guide

SWOT Based Questions

1. What do you think is positive when it comes to teamwork in your job environment?
2. What do you think is negative when it comes to teamwork in your job environment?
3. How could teamwork be even better?
4. What kind of problems could prevent better teamwork?

Follow Up Questions

- Could you please tell me more about....
- Could you please exemplify....
- How about....
- Can you explain what you mean with that?

Appendix B

Information letter/Informed Consent

We are very grateful that you have taken the time to let us interview you. We are Master's degree students in psychology at the University of Oslo. This year we will be writing our Master's thesis in cooperation with [REDACTED], evaluating how teamwork influences safety initiatives.

Data from this interview will, together with all the other interviews we will be performing, create the basis for our analysis. The aim with this interview is to gain knowledge, insights and understanding of what you have experienced, what your views are and your thoughts and feelings concerning teamwork in the organizational network, with an emphasis on the human side of safety.

We would like to tape record the interview so that important information will not be lost or forgotten. Only the two of us, together with our supervisors at the university will have access to the recordings. All the information you will be giving is anonymous and confidential. All names and personal identification will be deleted in the final thesis, and it will not be possible to trace any information back to you. Nothing you say will be known to any of your colleagues or to your employer. However, if you do not feel comfortable with recording the interview, we would like you to tell us, and the interview will not be recorded. Your participation is voluntary and you may, at any time, choose to end the session if you wish to do so. By answering the questions, you will give your consent to participate in this research.

The interview will be based on a technique called SWOT-analysis, aiming to shed light upon four aspects of teamwork and safety within the organizational network – strengths, weaknesses, opportunities and threats. The questions will be very open and general, so the focus in the interview will be largely up to you to decide. No answers are considered more correct than others; the only thing we are interested in is your honest opinion.

Date and place/Signature,
interviewer

Date and place/Signature,
interviewee