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ARTICLE

License to intervene: the role of team adaptation in balancing structure and flexibility in offshore operations

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Abstract

The study reported here reviewed and analyzed multi-team organizations in offshore operations to identify and understand the factors that are essential for good operation. It was found that the most prominent contribution to good operations was the balancing of structure and flexibility during work (anchor handling operations). The enabling factor towards this balance seems to be a process of team adaptation, including adjustments and corrections, when performing operations. The multi-teams operate in an open climate with a commonly accepted allowance to stop any safety-threatened operational activity. In practice, this gives the operational teams a "license" to intervene and adjust or adapt to suddenly occurring anomalies. The operations are in turn based on a period of planning and preparing. During the actual balancing, the teams relied on communication and information sharing, coordination and cooperation, and anticipation (proactive behavior) and empowerment/autonomy as effective enablers of team adaptation.

Keywords Leadership · Safety · Resilience · Adjustments · Multi-team · Proactivity

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1 Introduction: why study good operations?

Traditional safety management focuses mostly on adverse outcomes and how they are caused by individual and organizational dysfunctions, anomalies, and mistakes (Hollnagel 2014). This leads to a partial understanding of how an organization functions and to an asymmetry between the practical and conceptual tools—taxonomies, classification systems, models, and methods—that can be used to account for failures and accidents on the one hand and acceptable everyday performance on the other. The focus on failures leads to a fragmented view where causes are found and fixed one-by-one, as if they were independent of other organizational processes. It is rare to find safety analyses where the breadth of variability in individual and collective human performance is recognized and where the focus is to learn from what makes an organization work well (Hollnagel 2014; Aven 2018). There are, however, several benefits from looking at work as a continuous dynamic activity instead of examining random snapshots of failed performance. One is that safety management changes to support what goes well rather than eliminating risks and hazards. Another is that safety, productivity, and quality become facets of an organization's dynamic performance rather than separate foci. The article adopted this approach to review and analyze multi-team offshore operations to identify the factors that were essential for good operations. *The most prominent of these was balancing structure and flexibility enabled by a process of team adaptation*.

2 The empirical setting

Finding oil in the seabed is a comprehensive and complicated operation where a drilling rig is moved between locations in order to drill a planned number of wells to confirm whether the wells contain oil or are dry. Drilling a well may take several weeks during which the rig is anchored to the seabed by a spread of usually eight anchors connected to the rig by anchor lines of different length, but often up to 1500 m. Anchor handling and towing vessels (AHTV) are needed to recover the anchors and anchor lines onboard the AHTV, sail to the new location, reposition the anchors, move the rig, and connect to anchor lines (Fig. 1).

Traditionally, integrated rig move operations have been the dominating operational mode within anchor handling. This includes all elements of moving a floating rig from one operational field to another performed by 2–4 AHTVs coordinated from the rig. During the past 10 years, however, there has been an increase in the number of so-called pre-lay operations, where anchors are pre-set at the new location and lines being connected to floating surface buoys in a circle. This change has almost replaced integrated operations. At the time of rig move, the rig is de-coupled, the anchor lines are buoyed off, and the rig is towed or moved by its own machinery to the new location where all anchor lines are connected to the rig. A pre-lay operation is considered safer and more economical than an integrated operation as it normally takes 2–4 days involving one vessel to pre-lay and two vessels for the move and connecting operation.

Onboard, the AHTVs deck crew must connect anchor lines of different types according to specifications in the work plan or Scope of Work (SoW). Further, they connect the anchor lines to anchors, move the anchors from storage space along the

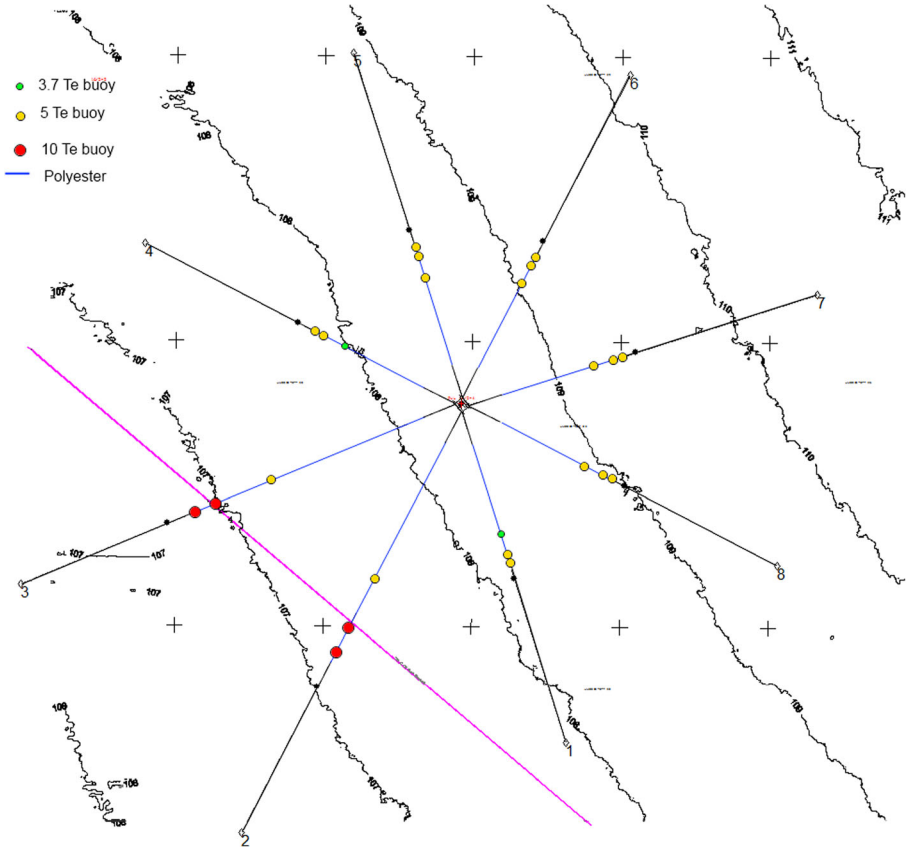

Fig. 1 Example of an anchor spread

railing of the vessel, connect buoys of different sizes if the anchors and anchor lines are pre-laid, and keep the deck tidy at all times to reduce risks. All this takes place in reverse when anchors are recovered from the sea to be set at a different location or transported to onshore base. An anchor weighs 12–22 tons and is about 3 m high. The ABs or deck hands use small flexible deck cranes in addition to tugger winches in order to move all chains and anchor lines, buoys, and anchors, but manual labor is still needed especially when connecting anchor lines using the so-called kenter links. The deck is the most dangerous workplace onboard, as anchor lines of different sizes often cross the deck under tension. The safety regulations therefore require all personnel to take safe positions when the bridge is tensioning the anchor lines.

3 The purpose

Despite the hazardous environment, most anchor handling operations go well. A fundamental research question is therefore why and how this happens and whether it is possible to tease out the factors that constitute the basis for good offshore operations. Although most operations go well, there is no definition of a good operation within the

offshore world. A briefing or evaluation is often carried out by a telephone call from the rig leader to the participating captains to provide feedback from the rig leadership on how well the operation went overall and on the contribution of the actual vessel, flexibility, use of time, and safety. Generally, positive feedback from the customer signifies a good operation. However, positive feedback mostly means that there were no adverse events. This echoes to the observation of Reason (2000, p. 3) that "safety is defined and measured more by its absence than by its presence." In the same way, good performance is defined by the absence of bad performance, rather than as something in itself.

The default assumptions seem to be that work goes well because systems are well designed, well built, and scrupulously maintained, because designers and managers have foreseen and anticipated everything that could happen, because procedures are correct, complete, and always up-to-date, because leadership is enlightened, and because people behave as they are expected to—as they are taught. A steadily growing number of studies have, however, shown that these assumptions are incorrect and that work goes well because people adjust what they do to match the conditions—including what others do (Barton and Sutcliffe 2009). In order to define more precisely what a good operation is, we chose to look at how adaptations and adjustments are made to meet unexpected challenges to usual work pattern and habits.

4 Theory

Studies of work in risky environments have traditionally focused on failures and accidents in order to learn from them. One of the most influential books about safety (Kletz 2001, org. 1988) aimed "to show, by analyzing accidents that have occurred, how we can learn more from accidents and thus be better able to prevent them occurring again." Work management has therefore paid more attention to the infrequent cases where something has gone wrong or could go wrong, than to the majority of cases where nothing unusual happened. In this approach, safety is defined as the "freedom from unacceptable risk or harm" or words to that effect, as a condition where as little as possible goes wrong. This interpretation of safety has been called Safety-I (Hollnagel 2014, p. 93). The term was chosen to distinguish it from another definition, appropriately called Safety-II, which characterizes safety as a condition where as much as possible—and ideally, everything—goes well. Where Safety-I only looks at what has gone wrong or what may go wrong, Safety-II looks at everything that happens or could happen—unacceptable and acceptable outcomes alike. This is similar to Power's proposition for a distinction between two research agendas: "One is to continue the work of connecting risk studies to mainstream organization and management studies. The other, related, agenda is to analyze the routine work of managing risk without the shadow of accidents and disasters hanging over it" Power (2016, p. 20).

4.1 Work as imagined and work as done

The intractable work environments that exist today mean that the way work is done always differs, sometimes significantly, from how it was imagined. When work goes well, it is because people are flexible and adaptive, rather than because everything has

been perfectly thought out and designed. This is a challenge to the theories and models that comprise the mainstream of safety engineering, human factors, and ergonomics (Hollnagel 2014; Westrum 1991). As the widespread emphasis on standards, regulation, and procedures shows, both safety and quality management assume that humans will perform as expected when given instructions in a specified work environment. Offshore operations, for instance, are governed by sets of rules and procedures in order to introduce predictability and reduce uncertainty. Humans do perform in a predictable manner, but since the scientific knowledge about what actually determines human performance is woefully incomplete, we are overall incapable of making realistic predictions. Yet organizations that rely on procedural frameworks must ensure sufficient flexibility to overcome the unexpected situation represented by shifting environments (Johannessen et al. 2015). To do so, we need to know more about what actually determines performance. Several authors have looked at the strategies that organizations rely on in order to balance this challenge (Bigley and Roberts 2001, Klein et al. 2006, Weick and Sutcliffe 2015). In this article, we will take a closer look at team adaptation in how offshore operations balance structure and flexibility.

Maynard et al. (2015) made an extensive literature survey of team adaptation, defined as the capacity of a team to make needed changes in response to a disruption or trigger. They found in their study that a majority of mediational relationships depend on communication and information sharing, coordination activities, and team cognition. The authors define these mediators to be "important to the way effective adaptation processes are applied and therefore they are assumed to influence the adaptation process–outcome relationship."

Within offshore operations, whether it is in subsea or anchor handling operations, team adaptation is used actively throughout the working processes. In this study, we found that *contextual understanding*, *communication and knowledge sharing*, *anticipation*, *empowerment*, *and coordination/cooperation* serve as enablers for team adaptation triggered by a decision to intervene in execution of the operations.

5 Methodology and analysis

This paper is based on extensive fieldwork were two researchers attended four anchor handling operations (two each). Two of them pre-set operations (anchors are set by one vessel in a pre-designed system prior to rig move) and two integrated rig moves (where both anchor handling and rig move is done during the same operation by 3–4 vessels) in the North Sea, Norwegian Sea, and Barents Sea during 2013 and 2014. The researchers attended one pre-planning meeting prior to all data collection as an introduction and observation of the planning process onshore. An account of this is outside the scope of this paper; however, it lays the foundation of the planning framework defining the actual task work onboard the vessels. The next step was the briefing meeting, called anchor meetings at the base prior to transit to the operation fields. At this meeting, the process owner, the operating oil company briefed responsible officers, and team leaders onboard all vessels contracted for the operation. This was in practice the first opportunity for the officers to test their understanding of the Scope of Work. Our focus in this article is on the operations performed from onboard the vessels.

5.1 Methodology

In addition, the following data were collected during the years 2013–2015:

- Interviews on field work onboard and onshore: 13 respondents
- Observation onboard 4 vessels documented by field log reports: 4
- Interview survey with captains and first officers by telephone to 11 additional vessels: 23 respondents
- Questionnaire to crews and officers identifying factors contributing to good operations: 48 respondents
- Focus group meetings onboard with officers and operation crews: 8 + 1 (with rig crew)

Respondents to interviews were captains, chief officers, marine representatives, deck foremen, and logistical controllers. In principle, the interviews provided an insight into their own reflections towards the operations (work-as-imagined), while the observations registered the actual behavior (work-as-done). The interviews were semi-structured with 13 standard questions focused mainly on communication, collaboration, incidents, prevention, and follow-up questions as needed. They lasted between 30 and 60 min and were all taped and transcribed in order to catch all details within respondents' expressed views. All respondents approved taping and were informed of our confidentiality code following the total process.

On average, the researchers observed the various stages of operations and life onboard 12 h a day for periods of 4–6 days (a total of 250 h) logging behavior, communication, collaboration, incidents between actors onboard, between vessels within the operation, and between vessels and the rig. The logs were updated when practicably possible during the day and as close as possible to the actual behavior or incident being described.

Anecdotes and examples have been extracted from the interviews, field logs, and focus group meetings. The replies are systematically examined in relation to the research questions identifying frequencies of processes and actions contributing to good operations. The field reports are similarly examined contributing to an overview of the data as what the respondents say, what researchers saw, combined into the elements of a pattern contributing to the research questions.

Data collected from interviews, survey questionnaire data, and observation data are analyzed in two data set: what they say, what we see. A screening of all available data in interviews, focus group meetings, and observation logs for references to and characterizations of good operations resulted in a list of 20 factors that were important contributors to good operations (Table 1).

These factors were all included in a questionnaire, which was given to 23 captains and chief officers onboard 11 anchor handling vessels. The questionnaires were returned completed and were supplemented by telephone interviews (lasting around 20–30 min). Chief officers together with operational crew onboard six other vessels participated in focus group meetings. The total number of respondents to the questionnaire was 48. The captains were interviewed separately in order not to influence the focus meetings with the crew. We wanted the meetings to be as open and including as possible in order for the participants to express their opinions, reflections, and feelings

Table 1 Initial list of factors seen as contributing to good performance

Clear role and task distribution	Delegating leadership behavior
Clarify expectations	Intervening behavior from bridge
Reacting to weak signals	Directing leadership behavior from bridge
Correcting things when occurring	Directing leadership behavior from rig on rig move
Being proactive on deck	Confirming understanding of orders and tasks
Good cooperation on deck	Good briefing in advance
Planning in advance	Debriefing and learning
Communication and cooperation between bridge and deck	Managing conflicts
Open culture onboard	Clarify imprecision, cloudiness, and ambiguities
No blaming following incidents	Basic communicated values; respondent requested to specify

towards the research question without long interventions from managerial positions with a potential of hampering discussions and expressions. The meetings started with a 15-min section with a view to individually complete the questionnaire identifying and prioritizing factors contributing to good operations. Further, the participants were requested during the rest of the meetings to explain their prioritized factors and the discussion started from there. In order to include reflections from captains, we arranged two focus group meetings with captains from different vessels to discuss their selected factors. The discussions were all taped with the participants' approval. They were all transcribed.

5.2 Limitations

Some criticism has been made of the use of focus groups; focus group participants may make up answers, dominant individuals can influence results, and you cannot depend on the result of focus groups (Krueger and Casey 2009). In this study, focus groups were used as one of four methods in order to supplement the understanding of the processes. By being aware of the potential methodological problems, we were able to avoid or limit them.

The researchers that were physically present in the focus group meetings did the analysis. This made it possible to test that the respondents' understanding and interpretation of the task and the initial list of factors actually were the same. In a few cases, the understanding had to be adjusted by some respondents following a brief discussion on interpretation and clarification of the factor thereby strengthening the verification of the data. The purpose of the focus group meetings was to clarify and elaborate on the previous individual prioritization of factors. The focus groups were used to generate a common understanding as the basis for analyzing the responses to the surveys, interviews, and observations.

5.3 Analysis

As already mentioned, the respondents were requested to prioritize the five of the most important factors contributing to a good operation, using their own definition of "good." In answering the questionnaires, each respondent prioritized the five factors

of 20 mentioned above that they thought contributed most to good operations. The score for each factor was used to calculate a weighted sum based on the number of scores. The total scores then divided this weighted sum for each of the factors, generating a weighted average for each of them.

Nine factors were mentioned more frequently than the others were (Table 2).

6 The multi-team system and the adaptation process

The main results from the observations were very similar to the results from the survey. However, the observations also provided additional factors contributing to good operations. As part of their work, the actors maintained a balance between executing the Scope of Work and adjustments and corrections they found necessary to do. These adaptations and adjustments were not described in the SoW and often are done by strategies such as collective problem solving and clarification of imprecisions, vagueness, and ambiguities.

The ability to collaborate within and between teams contributes to the making of a good operation. One of the interviewees said: "We have experienced a development from previous low degree of involvement and a lot of incidents, to a high degree of involvement and few incidents." Involvement depends on communication, which fosters collaboration. However, this platform of involvement depends on a series of things happening between people. One of the captains said: "It's all knit together, all the elements are important." The work is performed within a multi-team system, starting with a set of teams from several organizations doing the onshore planning. Authorized plans are presented to the executing parties in a planning and risk analysis meeting and sent onboard the participating vessels prior to departure for the oil and gas fields. Mathieu et al. (2001, p. 290) define a multi-team system (MTS) as "two or more teams that interface directly and interdependently in response to environmental contingencies toward the accomplishment of collective goals. MTS boundaries are defined by virtue of the fact that all teams within the system, while pursuing different proximal goals, share at least one common distal goal; and in doing so exhibit inputs, process and outcome interdependence with at least one other team in the system."

Communication across team borders will increase the understanding of the tasks and how they are supposed to be executed. Our data indicate that the form of

Table 2 The nine most frequently mentioned factors

Communication and cooperation between bridge and deck
Good briefing in advance
Good cooperation on deck
Planning in advance
Clear role and task distribution
Confirm understanding of task and orders
Being proactive on deck
Open culture onboard
Clarify imprecisions, cloudiness, and ambiguities

communication will, however, affect the degree of understanding and the amount of trust between the people working together. Finally, this may all have an effect on the way operations are performed.

Leading and coordinating the operation onboard, between the vessels and between vessels and rig, is observed as an overall gluing activity comprising the different inherent behaviors visualized in the factors enabling the adaptation processes (Table 3).

In addition to the factors in Table 1, Table 3 is derived from analysis of the fieldwork logs compared with the factors from Table 2. Summing up the analysis, we found that the following common factors or behaviors constitute a pattern that characterizes good operations every day, every week (Fig. 2).

These factors, which all can be observed and controlled regularly onboard the AHTV fleet on the Norwegian continental shelf, are described in more detail in the following, using the data and quotes from the collected material.

7 The input and basis for the team process: understanding context and situation

This contextual understanding is the foundation for task performance and execution of the operations. Empirically, this process involves understanding the setup, the work, understanding the environment, the forces and elements affecting the operations, and the resources needed to do the work. Further, the contextual understanding involves communicating this to the teams and making sense of the message, which is done by a combined safety assessment and task briefing during the transition phase prior to the performance.

One important element that affects the development and use of predictability is the use of tacit knowledge (Nonaka and von Krogh 2009) based on an intersubjective understanding of the context. Recognized key features, signals and cues in the environment represent a person's tacit knowledge developed during the experience, training, and the life at sea and during the operations. Ways must be found to develop this tacit knowledge and the individual contextual understanding applicable in a team situation into an "organized understanding or mental representation of knowledge that is shared by the team member" (Mathieu et al. 2005, p. 38). This corresponds to what is observed in the context of operations offshore. Sharing of tacit knowledge and

Table 3 The major factors from the total data contributing to good operations

Major factors	Covering the following underlying factors
Planning and preparing	
Briefing and assessments	Understanding the context Clear role/task distribution communicated
Coordination, communication, and cooperation (bridge - deck, vessel - rig, on deck, towards third parties)	Basic values: trust, respect, and openness Confirm understanding of order/task No blaming behavior
Proactive behavior (anticipation)	
Adaptations, adjustments, and corrections	Clarify imprecisions/cloudiness, ambiguities

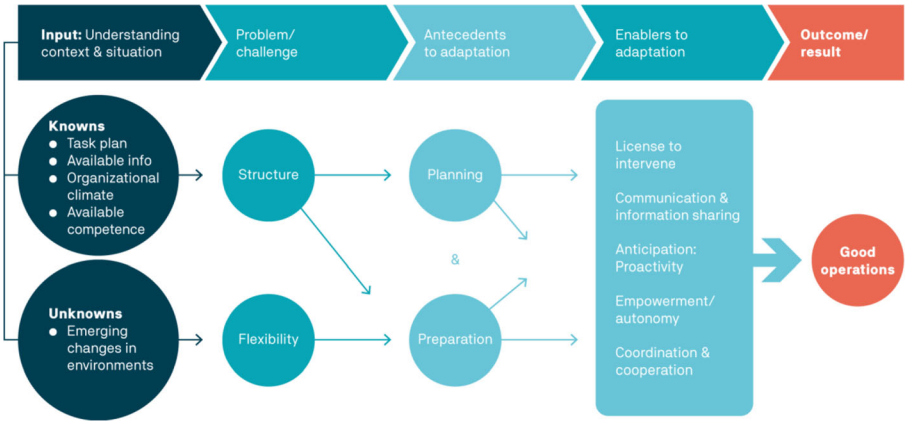

Fig. 2 Overview of the process towards good operations

contextual understanding is critical to team performance and creating of a good workflow within the team and multi-team (Jonassen 2015) and is a foundation for good and safe operations during the action phase.

8 The team challenge: balancing structure and flexibility

Research spanning a quarter of a century have studied organizations engaged in high-risk work, with tightly coupled operations performed in unpredictable and often volatile environments (Roberts 1990; Weick and Roberts 1993; Bigley and Roberts 2001; Johannessen et al. 2015). These are organizations allowing low tolerance for mistakes. The introduction and use of rules, guidelines, and work plans as a basis for operations offshore creates a structure necessary for individuals and teams to understand the framework they will be working within and the actual tasks they will perform. Together with the crews' collective competence and their knowledge of each other's' competence, this structure will represent a certain degree of predictability as a baseline for safe behavior (*the knowns*, ref. Fig. 2). Weick and Sutcliffe illustrate how operators in High Reliability Organizations (HROs) build "a broad awareness of the current operations captured in the image of "having a bubble" (Weick and Sutcliffe 2015, p. 82). "To sustain a bubble", Weick and Sutcliffe argue, "is to make an effort to assemble complex inputs into a map, a frame of reference, and a definition of the situation, in other words, a plausible story." This "integrated map" is guiding the operators' collaborative behavior towards integration of their actions, often without oral communication. Our researchers have observed this concerted behavior as their habitual operative behavior, their "modus operandi." The crews' ability to perform within the procedural structure is challenged by the special volatile environment and unpredictability of people collaborating in the handling of technology. The situation will from time to time need flexibility in order to solve occurring problems rising from unexpected changes in those environments (*the unknowns*). Faraj and Xiao describes the phenomenon as: "… on the one hand, there is a need for tight structuring, formal coordination, and hierarchical decision making to ensure a clear division of responsibilities, prompt decision processes, and timely action; but, on the other hand, because of the need for rapid action and the uncertain

environment, there is a competing need to rely on flexible structures, on-the-spot decision making, and informal coordination modes. Thus, such organizations paradoxically emphasize both formal and improvised coordination mechanisms" (Faraj and Xiao 2006, p. 1157). This need for flexibility is a challenge to the assumption that plans, rules, and regulations are sufficient to govern performance. The balancing of structure and flexibility is therefore necessary and a success factor in order to handle adaptations and adjustments to avoid serious incidents and accidents.

"While the concept of balancing structure and flexibility is broadly accepted as a key success factor in reliability-seeking organizations," Johannessen et al. argue, "research continues to examine how this balance operates in practice; for example, *who* makes decisions when unexpected and disruptive events occur, ..and to what degree actions are taken outside or within existing procedures" (Johannessen et al. 2015; Barton and Sutcliffe 2009). This current article is a contribution towards the call for more empirically oriented research on the process of balance between structure and flexibility.

The work plan in anchor handling allows for a certain degree of flexibility in how the crew is working. Most captains of anchor-handling vessels (AHTV) in the study placed basic trust in the deck team and the deck bosun. The team was empowered to perform and thus delivered results productively and of high quality. The flow of their work sometimes resembled a choreographed ballet where the actors know what to do without further discussions. They resolved unexpected problems with coordination by cues and knowledge of each other's resources (Vandeskog 2017). The captain oversaw the operation together with the first officer from the bridge with a perfect view to about 2/3 of the deck area. The view, however, also gives a captain the advantage and the temptation to direct the deck work in detail. Most captains in our data material resisted this type of directing and performed a more laid-back style only to intervene when necessary in situations where the team failed to spot cues of risky elements that potentially threatened safety and quality. One of the bosuns told the researcher, without any prompting, that one of the good things about this ship is that there is very little interference by the bridge into what they do on deck. They have read the SoW or are briefed by their bosun. They know what is going to be done, and as long as they do it right, the bridge refrains from interfering: "The bridge shows trust and trusts that we are competent. If you get someone on the bridge who gives directives all the time it makes you stressed and you get to rely on them telling you what to do."

This is in line with the principle of allocating responsibility for managing risk to those best placed to control them. Aven and Renn (2018) explain: "It reflects the basic idea that 'one cannot be held responsible if one is not in control.'"

During the focus group meetings with the captains, they pinpointed the importance for all operating crew to understand the context and the impact of the changing environment as a pre-requisite for safe behavior onboard. This understanding started during collective briefings and knowledge sharing. The understanding of the general context of these offshore operations implies an understanding of the known basis which is affecting the execution of the operations, including the task plan and all other available information of what the crew can expect to experience; the weather, the impact of currents, the position of other vessels, etc. The competence of the crews and the organizational climate onboard are known to a certain extent. These are all factors fostering the ability of the teams to master the balance of structure and flexibility; the balance of compliance to a structured plan and procedures and the need for flexibility when sudden unexpected changes occur. The understanding of

unknown factors that may have an impact on the performance of the operations stems from previous experience and knowledge of how to handle sudden unexpected incidents (Jonassen 2015; Johannessen et al. 2015). This is a collective knowledge of the complete multi-team system acting in concert just like the symphony orchestra required to create the sound of a symphony (Vandeskog 2017).

As teams adapt to changing and unknown circumstances, they engage in a process of adaptation to these circumstances and the environment. Figure 2 (see Section 6) is partly based on the ideas of Maynard and colleagues (Maynard et al. 2015) and is illustrating the operational process.

9 Antecedents to adaptation: planning and preparing

9.1 Distal onshore planning

The planning of an offshore operation like an anchor handling and towing operation is performed ashore by several specialist parties. The operator, an oil company representing a license, will contract the relevant expert companies according to their own type of organization, competence, and capacity: marine planning, surveying, drilling, mooring equipment, drill planning and engineering, and marine management.

The planning of the operations is done onshore based on the tasks, requirements, and regulations set by the regulating and controlling authorities and the industry cooperating bodies. Together with the SoW, this is meant to create predictability, creating calmness in the personnel, and reducing possible anxiety (Jonassen 2015). This process of remote planning establishes a common understanding of the work situation that is needed for safe execution of the operation. A prime purpose of the plan is to structure behavior (Miller et al. 1960). Plans are the programs of action, the instructions for what to do and how to do it under this and that eventuality. The prior or distal planning establishes a framework for performance including the local plan or proximal plan.

9.2 Local onboard preparations

The preparations done prior to the actual operations are based on the assessment of the situation in the moment. This local planning comes in the form of adjustments and necessary corrections prior to operation. The local onboard planning and preparation start with the mobilization of all equipment and personnel. A captain will proactively make sure that all equipment is loaded onboard, fully prepared, and placed in the right place and order. The flukes (wings) of the anchors are pre-set in the prescribed angle according to SoW while still on the quay before loading. In this way, the space is better used and the job is done quicker.

> "Planning is some of the most important things we do. By that, I mean logistics; a lot of equipment has to be placed and if this is not done correctly, it will all be a mess. This has to be the first thing to come in place. You have to know where the equipment is going. There are many chains, wires and a lot of fiber lines and you

> have to think through how it all is going out, in what order. This is terribly important. It's logistics, right out."
> Captain

Anchor lines, fiber lines, chains, or wires are stored in huge box-rooms below deck according to "last in–first out" principle. If this is mixed up, considerable time is lost in sorting out the mess. One of the researchers observed a situation, were such a mistake was the result of the captain choosing not to arrange a planning meeting with the mooring equipment representative discussing the right sequence for the different parts of the anchor lines. They were all in a mess and valuable time was lost. The mooring equipment, anchor wires, anchor chains or fiber lines, kenter links, other couplings, and buoys, are often hired for the time the rig is planned to drill. The companies use to send controllers onboard for most trips in order to oversee mobilization and demobilization and to document ownership and licensing of all equipment by recording a unique number for each piece of equipment going into the sea. A proactive captain uses the availability of these controllers as a resource. Some anchor lines, often stretching between 1.000 and 1.500 m, could be owned by several companies; the oil company, drilling company, or the mooring company. Imagine the complexity when each part of the total equipment has to be certified for the actual period standing in the sea. A breach where uncertified equipment goes into the sea could result in disastrous consequences leading to the wreckage of a rig and casuals. Accordingly, the state of the equipment must be documented.

One of the team bosuns summarizes the importance of planning and flexibility as prerequisite for a good operation as such: "The most important is planning prior to operation. When we attend briefing, there is a great need for information on what is going to happen, especially for the deck people. When we read the SoW, prepare the operation in the dirty mess and tell them we are doing this or that, it is a basis for them. Set up or other things may change when we are out there resulting in things that are not exactly, as they were planned to be. This requires improvisations during operations and things have often to be handled quickly."

10 The onboard adaptation processes

Adaptations, adjustments, and corrections are ubiquitous and inevitable during operations. During collaboration on deck and between deck and bridge, situations occur that could develop into unwanted incidents if had they not been stopped, adjusted, corrected, or adapted. An unusual sound may communicate an emerging weakness or breach in a wire or chain running across the deck. Our interviews reveal instances where signs and cues trigger crews to stop the operation reflect and react to check anomalies and decide appropriate action in a matter of seconds. This is clearly supported by observation by our researchers. The survey (ref. Section 11.2), however, reveal that people are more aware of factors which enable adaptations (ref. Section 11) rather than actual adaptations, adjustments, and corrections. Very few mention adaption as the most important factor contributing to good operations, an illustration of the relationship, and the difference between work-as-imagined and work-as-done.

Task plan and procedure may be challenged by reality as the deck hands work in these rapidly changing environments. The weather can change in a moment. Forecasts

are general and cover huge areas, missing out local variations. Waves, stream, swell, and human behavior will affect the work in various and often unpredictable ways. The environment is also unpredictable by the modifications required by the rig due to changes in their needs and adaptation to the evolving operation. Current rules and procedures are unable to cover such complexity and uncertainty in order to represent a holistic guide to human behavior and interaction (Bieder and Bourrier 2013, p. 277).

Barton and Sutcliffe 2009 describe situations where lack of interruptions can develop into a dysfunctional momentum; a flow of uninterrupted dysfunctions and anomalies not re-evaluated, adjusted, or otherwise acted upon. They argue: "Evidence from this study suggests that interruption becomes a critical driver of safety insofar as it triggers sense-making and re-evaluation." These challenges and changing conditions require a different and more flexible set of strategies and tools than implementing plans and compliance to procedures can offer: *adjustments*, *adaptations*, *and corrections*. Our empirical data reveal teams reacting to overcome dysfunctional momentum actively adapt to sudden changes by re-evaluating and intervening.

In the following, we describe empirical findings from offshore operations within the adaptation processes.

Through the multi-teams' varied and total competence, these anomalies and incidents are evaluated and adjustments and corrections are executed as though it was all a part of the plan. "People can (also) detect and correct when something goes wrong or when it is about to go wrong, so they can intervene before the situation becomes seriously worsened," argues Hollnagel (2014).

When things have gone well, we often find the explanation in the interventions and adjustments individuals and teams have made (Barton and Sutcliffe 2009). This is also clear from our empirical data, especially from observation periods. Adjustments are performed during all phases of an operation. Local planning and preparation onboard, for example, is an adjustment of remote plans towards prospected changes in the circumstances before action. Implementing the plans may involve unexpected changes or anomalies suddenly appearing during operations.

11 Enablers to adaptation

A pattern is emerging from our data revealing five enabling processes supporting adaptation during operations: *intervening in operations*, *communication*, *information and knowledge sharing*, *anticipation/proactivity*, *empowerment and autonomy*, *and finally coordination and cooperation*. This corresponds to the findings within literature (Maynard et al. 2015); however, the literature is scarce in putting these constructs into an empirical setting.

11.1 License to intervene in operations

11.1.1 Openness, a basis for safety

By active cooperation, three parties, the relevant authorities, the industry organizations, and the branch unions, agreed and established a principle of stop-allowance; every single individual engaged in oil and gas operations will be allowed to stop any

operation if he/she feel unsafe or unsecure without any reprisal, whatsoever (Skarholt et al. 2017; Øyum et al. 2010). This is ever since considered as a backbone within the safety culture offshore on the Norwegian continental shelf. Studies confirm that it is a reality in offshore daily life. It supports Norwegian national values like egalitarianism and trust, which is seen as contributing to a climate of openness in the workplace (Skarholt et al. 2017; Jonassen 2015). Openness represents the freedom to fail and stop without repercussions. The result of this type of climate is individual and team psychological safety that allows individuals to speak up towards what is considered unsafe practices and solutions resulting in evaluation of the plan and barriers (Burke et al. 2006, p. 1194, D'Innocenzo et al. 2016, p. 1294). A captain explained: "The threshold for anyone to speak up when there is a danger shall be low, it depends a bit on whether people know each other, whether people dare speak up if something unwanted happens or if someone is standing in the wrong place. You should not be afraid of speaking up. You do it to protect your team mates."

Team psychological safety is by Edmondson (1999) defined as "the shared belief that the team is safe for interpersonal risk taking." Edmondson describes this as an indirect effect facilitating members to respond appropriately to accomplish the work in a safe manner. It allows each team member to raise their voice towards uncomfortable solutions allowing for increased safety and quality. Researchers have labeled this type of climate as Voice Climate, being defined as "the shared perception among unit members regarding the extent to which they are encouraged to speak up and make suggestions in the workplace" (Burke et al. 2006, p. 1194). This open climate facilitates creativity in problem solving and a balance of structure and flexibility when the unexpected occur. One of the captains claims: "We would not have these anchor-handling operations in the North Sea if it were not for the deck hands' participation and suggesting improvements. This affects safety and all. I notice that the more I involve myself, the more feedback I receive."

This allowance to speak up relates to the whole of the multi-team system, including the relations between the vessels and between the vessel officers and the rig management. This is, however, a delicate relation to challenge. The vessels, often from different shipping companies, relate to the rig company by a contract allowing the rig to take vessels off hire when inoperative, for example, in bad weather. The contract usually offers a commonly branch negotiated limit for acceptable wave heights during operations. However, this limit can be measured and interpreted differently, resulting in a situation where single vessels could be vulnerable in an argument towards the rig. To avoid situations like that, putting single vessels in a blame position, the branch parties have negotiated and implemented a system of representation. One of the vessels is elected by the collaborating parties to act as representative HSE vessel towards the rig management in cases where a decision has to be taken to bring the vessels in a waiting position until weather or other safety threatening situations terminate.

11.1.2 From speaking up to intervention

Speaking up on anomalies and concerns create an opportunity for reflection and rethinking the chosen solution or strategy. Barton and Sutcliffe (2009) studied wildland fires and found "Evidence from this study suggests that interruption becomes a critical driver of safety insofar as it triggers sense-making and re-evaluation. Furthermore,

rather than waiting for environmental factors to interrupt action (by which time it is usually too late), organizations will be safer to the extent that the individuals involved create their own interruptions by articulating their concerns and by actively seeking out disparate perspectives in the events underway."

Interruption is not enough; however, our observation data shows. Individuals and teams take the interruptions beyond reflections into interventions by correcting, adjusting, or adaption to the changing conditions. The commonly agreed regime of openness and allowance to stop operations legalize a "license" to intervene and solve the occurring anomalies and problems.

11.2 Communication and information and knowledge sharing

A total of 48 captains and deck crew (23 by telephone and 25 during dedicated focus group meetings) onboard 17 anchor handling vessels were asked in a survey to range the five most important factors contributing to a good performed operation. The survey reveals four factors contributing to communication and information and knowledge sharing, which represent 30% of the responses, namely briefings prior to operation, clarification of cloudiness and ambiguities, and thirdly debriefings and learning.

11.2.1 Briefings prior to operations

The onshore planning is finalized by the work plan, so-called SoW, which is presented to a work and safety assessment where all parties are represented, finalize the plan, and further present to the vessel at an "anchor meeting" prior to mobilization at base.

The captain usually arranges a briefing meeting or safety assessment meeting on transit to the location where the main purpose is to familiarize the crews with the task plan and challenges ahead on location. Communicating a clear role and task distribution will prevent confusion, reduce risks, and contribute to both effective and efficient operations.

11.2.2 Clarification of cloudiness and confirmed understanding

Clear leading behavior together with a clear confirmation of the understanding from team members on tasks and orders will help prevent misunderstanding. In BRM (Bridge Resource Management), this is called "Closed-loop" communication (Rynd 2017). If orders are given and there is no confirmation, the order-giver has no indication of the correct understanding from the point of view of the receiver responsible for executing the order. This lost opportunity could result in serious consequences. It is a clear opportunity for leaders to check the sense making of their message. The task information is required to perform good operations. It is necessary that all personnel absorb and understand the information in order to make the right choices along the way. Recognizing the cues and patterns that indicate anomalies will be proof of that understanding. There has to take place both an individual and a collective cognitive comparison of these cues towards the existing knowledge structure and the crews' own mindset before performing the operation (Burke et al. 2006). This is an opportunity for leaders to test the task comprehension as a confirmation or not on the maturity of the executing teams to act more or less autonomously.

11.2.3 Learning and implicit coordination

Team members develop a commonly understood tacit knowledge when working tightly coupled in small teams over a length of time. They will know each other's competence, strengths, and weaknesses and can substitute or supplement knowledge according to the challenge ahead. This enables the members to collaborate effectively even in silence acting (Vandeskog 2017) on cues, signs, and body language effective in the team as coordinating mechanisms. Reber (1989, p. 219) examined the relation between implicit learning and tacit knowledge. The research and discussion of whether implicit knowledge was an unconscious or a conscious effort to learn was by then a couple of decades old. Reber concluded in his paper: "Implicit learning produces a tacit knowledge base that is abstract and representative of the structure of the environment and such knowledge is optimally acquired independently of conscious effort to learn; and it can be implicit to solve problems and make accurate decisions about novel stimulus circumstances." Later research by Nonaka and von Krogh (2009) argued that tacit and explicit knowledge could be explained along a continuum both theoretically and empirically. Knowledge conversion explains the interaction between them. Our respondents explain that their knowledge comes from years of experience in the same type of operations, but under changing conditions.

This is clearly observed by our researchers. It enabled the team to solve unexpected problems only using their collective experience. Entin and Serfaty (1999) called this type of self-coordinated behavior "implicit coordination, requiring that members draw from their shared tacit knowledge (which they called mental models) to anticipate and meet the needs of their teammates without being asked. Implicit coordination is particularly useful during periods of high stress, because it serves to decrease workload" (referred in Burke et al. 2006, p. 1197). However, Entin and Serfaty found that during routine work, explicit or overt coordination might be more appropriate. One of the delegating captains explains: "If you have worked with this type of operations for some time, I think the more backward leaning attitude is better. You can see what people are doing (from the bridge), and if they do it all right, there is no meaning in sticking the fingers in and comment. When things are flowing its usual flow, and people do the right things it is always the birds eye perspective we have from the bridge that will help in the moment. By that we help each other, but avoid the unnecessary nagging."

On-the-job-training takes place in between tasks whenever needed. Team members learn from each other, from their bosun and from the controllers who are working along with the deck team controlling equipment and registering the numbers on each part going down in the ocean. These controllers are often experienced deck hands or officers migrating between the vessels. This puts them in a unique position to transfer knowledge between the vessels on both new types of equipment and ways of operating. The controllers report of mainly an openness towards them and an interest in learning whatever tips they can offer. However, some individuals or teams seem eager to protect their domain and express a warning towards being "instructed." Our researchers have also noted a lack of formal and scheduled events where learning and reflection is the main purpose. They refer to lack of time as an explanation. Recent research, however, has reported a clear impact on performance of more than 20% improvement from a 15 min a day break to reflect on lessons learnt during the day (Gino and Staats 2015). Therefore, formalizing time to reflect may positively affect good operations.

11.3 Anticipation: creating proactive behavior

> "I think it is unbelievably important that someone is thinking ahead all the way"
> Captain

Proactive behavior is resulting from a cognitive process of anticipation or what Adamski and Westrum (2003) called *requisite imagination*, meaning: "the ability to imagine key aspects of the future we are planning … The fine art of anticipating what might go wrong means taking sufficient time to reflect on the design to identify and acknowledge potential problems. The failure to use requisite imagination opens the door to the threat of unanticipated outcomes. These outcomes can be incidents, accidents, or major catastrophes." Enabling people to focus throughout the ongoing operation is a continuous challenge for both leading personnel and teammates in this kind of rapidly changing environments. One of the equipment controllers put it this way: "The art is to facilitate people into focusing and concentration. This is actually underrated." That is the real aim of requisite imagination: the unbiased anticipation of what can happen way before it happens. Acting based on such reflection is the essence of being proactive.

Being deck hands onboard offshore vessels requires a developed ability to spot and interpret the environment and make quick decisions regarding changes and unexpected incidents. They watch each other if anyone should happen to be unaware or mindless and stay in the wrong place. Moreover, they have to be able to translate small cues warning emerging changes into an assessment of the total situation using their knowledge of the plan and environments to foresee what could happen and react preventively.

> Experience is important and an understanding for what is happening. It is going to be so much easier if you have an understanding for the job you are doing; it goes for safety as well. You are just a few meters from getting in the sea, so you have to think of the possibility. That is why it is not happening, because you think of it.
> Chief Officer onboard AHTV

The operational crew operates as an entity where the bridge team is not just leaders of the total operations; they also serve as the deck team's "third eye," warning about potential dangerous situations. One of our researchers observed: "I argue that when something happens, successful solutions to the problems depend on teamwork that flows smoothly and gracefully because team-members are able to assume each other's positions and anticipate what the others will do without verbalizing it" (Vandeskog 2017).

The basis for anticipating other people's behavior and changes in the environment is a habit of reflecting on what can happen from doing what is intended and planned. Based on that information, you are able to move from work-as-imagined to work-as-done. An incident from an AHTV in the Barents Sea reported by one of our project partners illustrates the potential of such a habit. The vessel had secured the anchor chain in the port shark jaw (a solid bolt split on top to keep chain in place) and the chain connected to the rig was secured in the starboard shark jaw. The anchor chain was ready

to be lowered to the seabed. Crew reported cleared deck and the winch driver tensioned up the anchor chain for a release from the port shark jaw. The officer in charge ordered, "Down with the shark jaw!" and the winch driver lowered the starboard shark jaw, resulting in 700 m of chain dropped onto the seabed.

This incident resulted in loss of time and extra costs, but luckily no injuries, and the chain was recovered. It was reported as a human error without further explanation. A good operation might have avoided this incident by anticipating what would happen if the starboard shark jaw was lowered. By thinking ahead the officer, operating the winches could have checked with the chief officer giving orders to clarify the order a moment before acting. If the officer in charge requested a confirmation or repeat of the order, this could also have prevented a misunderstanding.

11.3.1 Backup behavior

Backup behavior in anchor handling operations is complementary behavior with the purpose of creating a "safety valve" for others in the crew. Crew members are observing and monitoring each other's behavior with direct communication between them to contribute to performance quality and safety. Monitoring can be formalized as a task and allocated to dedicated positions within the organization. In that sense, the function could be characterized as redundant and not complementary (Burke et al. 2006). The type of backup behavior in anchor handling operations is clearly complementary in nature, differ from the type of backup behavior found in subsea operations, which were not formalized, but executed by members of the multi-team not in an active role within the ongoing operation. In subsea operations they represent a more free and independent role towards the operations, called informal leadership redundancy (Johannessen et al. 2015).

Backup behavior was executed and being expected by all teammates and officers on the bridge with a view to all the action. One of the crew members argued: "We are each other's third eye!" One of the captains stated: "May be it's coincidence, but we (on the bridge) often speak out, let us say the team on deck starts to work with tugger winches (small winches on deck to move anchors or buoys, etc.) where wires are tensioned, they are in the middle of the firing line if a wire is breaking. Then we often intervene to guide them into safe positions. Nothing has happened, but it could be serious by the wrong positioning. It is very important that we all watch for each other; the people on deck look out, on the bridge, that we all are open to speak out. I think, however, we are more aware the greater the potential for danger is. One gets more relaxed when the situation is not that dangerous, but this is often the time when we get these small incidents."

11.4 Empowerment and autonomy

The ability to create a seamless flow of four anchor handling vessels sailing in and out from the rig connecting or disconnecting anchor lines lies with the collaboration of the captains with the rig master (OIM, Offshore Installation Manager) or tow master. The scenario often involves a tight balance between structure and flexibility (Johannessen et al. 2015). The total Scope of Work (SoW) is designed onshore based on all available information and involves the specialization and expertise from several companies (ref.

Section 2). However, as the ocean and seabed keep changing, the parameters change and the actors onboard often have to make decisions based on incomplete knowledge relative to the SoW. The ability to act flexible outside the SoW represents challenges to both the rig master (OIM) and the vessels' masters. Their ability to balance the challenges will affect their success rate.

During one of the most complicated rig move operations, as our researchers observed in the field, the rig master deviates from the SoW by inviting the vessel captains to contribute to solutions that are more flexible. This triggered the motivation of the captains to offer extra capacity and creativity resulting in a flow, characterized by "our" captain as "one of the best rig moves I have ever taken part in." The trend throughout the past years has been to delegate more and more autonomy to the vessels for the work done onboard and the coordination during rig move and anchor dis- and connecting operations.

11.4.1 Empowerment foster proactivity

The officers on the bridge affect the ability of the deck team to act proactively, according to our findings. We have earlier referred to research finding that more autonomy to teams will have a positive impact on performance (D'Innocenzo et al. 2016). If the deck team has autonomy on how to perform the instructions from bridge officers or directly from SoW, they are able to plan for the next task as soon as finalizing the previous. This proactively ensures a flow during operations building a capacity also towards managing safety.

D'Innocenzo et al. (2016) found that empowerment is especially important in complex and dynamic settings such as hospitals. Our research support this in other settings like offshore operations facing the same kind of complexity when it comes to the relationship between human interaction and handling technology and unexpected interference from the environments. Laschinger (2008) found that empowerment enhanced nurses' proactive behaviors directed towards the prioritization of patient care. In offshore operations, we found support for this finding in our data as illustrated by the following story told by a marine representative: "I was told by a captain of an AHTV that his boat always was the latest to finish their jobs during rig moves. He could not think of any solution to improve, so he asked the other captains one day, what they did. They told him there are two important things we do in order to effectively, do our jobs. We let the deck team have control over their own tasks, by that they behave more self-reliant and will be more proactive. When being more proactive, they will clear the deck to prepare for the next job as soon as the previous is done. That was a wake-up call for him and he managed to do the same things onboard his own vessel. He has never been late since."

Officers' proactive intervening from the bridge will increase the possibility to supplement delegation of authority to the deck team, preventing mistakes or reducing the potential consequences of mistakes. Officers on the bridge have a bird's eye view of two-thirds of the deck enabling the officers to offer a "third eye" to each of the deck hands.

The delegating captain is proactively building his team to act independently based on their own competence and evaluation of the situation: "To supplement the briefing I have copied the line drawings and laminated them to be kept in the dirty mess. On the drawing, all anchor lines are drawn correctly, so the team will know exactly what to do.

We are guiding them from the bridge, but on the whole they know what to do." How can proactivity within the teams and between them be developed? As illustrated in the above example, proactivity must be built on an empowered climate onboard. Within the framework of a procedure and a SoW, the team must be given power to make decisions steering their own behavior. This will make sense of the use of requisite imagination as a last safety and quality assessment before acting: Is the order understood correctly? Is the intended action appropriate for the situation? One can only speculate what may happen if this is not the case.

11.4.2 Breach of procedures

Procedures based on regulations and standards are the cornerstone guiding offshore operations. It represents structure and predictability as a foundation for the work. Sudden changes in the environment, however, require flexibility in finding and executing a solution. This challenge may involve breaking the procedures. The collective competence of the actual team compensate for the value of the procedure, report our researchers observed at every step of the operations offshore. Vandeskog, one of our researchers, refers in his paper an incident where the huge drum on the main winch went totally stuck preventing further operations. The deck crew, the bosun, and two deck hands went to work out a solution to the problem without a prior toolbox conversation. The crew collaborated with a few one-letter words, silently, but firmly through one try that did not work out and the following successful attempt. The researcher noted that from the outset, the deck team did not follow the procedures and safety rules for managing a situation like that. Their actions were not interpreted by the researcher as a protest towards procedures as hindrance to effective work or as an ignoring of them. They just seemed to be irrelevant for the situation at hand. Where procedures required verbalizing, risk assessment, role distribution, and planning in stages, the actual problem situation required self-reliance, collaboration, and an implicit understanding and anticipation of each other's plans and next actions (Vandeskog 2017).

Nævestad et al. (2018) also report cases of breached procedures from maritime operations on coastal freighters, for example, in a study: "Most interviewees underlined that 'common sense' is the most valuable safety measure. Thus, the informal safety culture may also compensate for poorly adapted or inappropriate formal procedures." They call for more research on this matter. Our study contributes towards the call.

11.5 Coordination and cooperation

Referring to the survey in Section 11.2, it reveal three contributing factors to coordination and cooperation, representing 42% of the weighted (ref. analysis in Section 5) prioritized factors for good operations. These contributing factors are coordination and open communication, cooperation at all levels onboard and clear role and task distribution.

From field observation, we have seen coordination and communication unfolding as an act of balancing control, directing, and autonomy. This process of leading, based on the prime values as trust, is emerging from respect and an open climate. This is clearly observed by our researchers as an active behavior by most captains and first officers onboard the participating vessels.

11.5.1 Coordinating and directing

Just as briefing is used at one end of the control continuum, explicit or overt coordination is used at the other (Burke et al. 2006). Bridge officers oversee the operation by means of several video monitors displaying activity in relevant parts of the vessel and from the Remotely Operated Vehicle (ROV) when it is down beneath and through panorama windows towards the deck. The deck crews are all equipped with radio earphones and microphones allowing constant contact with each other, their bosun, and the officers at the bridge. This offers the opportunity for the officers to both facilitate the work on deck, to monitor or to direct the work in detail. The two controllers onboard illustrated this: "He (the captain) admitted himself that he directed very often because he has the overview from the bridge. The deck people confirm that it is a lot and that they lose some of the motivation. We don't get the same joy to work when commanded … This is a leadership trap: In the end of the road you end up with people not thinking on their own." We only encountered a single captain playing this game. During the demobilization of equipment from that vessel, the researcher witnessed an incident that may illustrate such a leadership trap. When unloading anchor chains onto the quay, the captain left the rear bridge overlooking the work area on deck for a telephone call at the forward section of the bridge. A vacuum in the usual detailed directing from the captain left the deck crew a bit unoccupied for a while. The first officer tensioned the tugger wire in order to facilitate the unloading of the anchors when it suddenly broke and flipped along the deck only inches from the head of one of the deck hands. Luckily there were no injuries, but close.

Of all the 21, other AHTV vessels we visited or contacted, we could not find evidence for that type of leading behavior (detailed directing and controlling). However, with the six multi-purpose subsea vessels we visited, we encountered one captain of the sort. Within the continuum of control—autonomy, a range of leadership behavior unfolds, but most of the leading behavior we have encountered at the Norwegian continental shelf draw towards the autonomy part of the continuum.

Burke et al. (2006) proposed that coordination depends on shared mental models, a sense of psychological safety, clear roles, and responsibilities and an understanding of each other's roles and mutual respect for them. Our research complements this finding although the term "shared mental models" is in our analysis replaced by the process of implicit coordination, where team members draw from their tacit knowledge (Entin and Serfaty 1999 and Nonaka and von Krogh 2009). Our data identified that believed values like respect and trust is an additional important underlying factor. Accepted and enacted values are a basis for the development of psychological safety and "a leading behavior which facilitates the coordination of teams leading to quality in planning and execution" (Jonassen 2015, p. 59). The values are also drivers for openness in the work place, which is necessary for sharing ideas, solutions, and knowledge among the team members (Jonassen 2015; Burke et al. 2006).

11.5.2 Cooperation and collective problem solving

The ability to adjust and correct the problem right away without losing time in scapegoating is an obvious strength in this type of complex organizations working under extreme conditions.

One of the researchers noted this incident, which may illustrate this ability: The bridge officer gave order to prepare for the launch of the ROV. The team leader checked the monitor, turned worried, and spoke on the radio to the bridge. He explained that a pump was still running from the last ROV launch. It was not turned off. The pump needs cooling and due to running in the air above the cooling water, it was running hot. In worst case, this could overheat the hydraulic oil and break the pump. They had to check this before further launch into sea. This took 2 h. As by previous situations that needed adjustments, the focus immediately was on finding a solution rather than to find a cause and determine whose fault this was. The team leader went up to the bridge for a work permit and down to check the ROV together with the two pilots. He let them do the repair job as they had the responsibility for all maintenance and running of "their ROV."

Summing up, clear roles and responsibilities, open communication, coordination, and collaboration between individuals within teams and between units within a multi-team organization, constitute a backbone of good and effective offshore operations. Milch and Laumann (2016) found that "investigations into several large scale organizational accidents have shown that issues with roles and responsibilities, communication and coordination between organizations were contributing factors leading up to accident scenarios like Deepwater Horizon" (e.g., Tinmannsvik et al. 2011, p. 10).

12 Summary and conclusion: on the road to good operations

This paper has shown the importance of paying attention to how work is done and to understand the nature of work as a continuous and dynamic whole rather than to focus on the random snapshots of failed performance represented by accidents and incidents. While the data from multiple sources, observations, interviews, questionnaires, and focus groups defy simple categories, it is nevertheless possible and indeed quite easy to find recurrent patterns. The major patterns addressed the challenge of managing the balance of structure and flexibility. This balance was achieved through a process comprising adaptations, adjustments, and corrections, preceded by a period of planning. When unexpected events or cues emerge, the operating team relied on communication and information sharing, coordination and cooperation, anticipation (proactive behavior), and empowerment/autonomy as enablers to maintain the balance. The detailed analyses showed how these patterns or factors contributed to a successful outcome of the anchor handling operations.

The findings from this study correspond to what has been found in studies from other domains as well. Indeed, since the practices and principles of resilience engineering were first formulated (Hollnagel et al. 2006), a growing number of studies that looked at the practices that emerge from daily work have made similar finding. While each study naturally highlights what is domain specific, it is possible to look across studies for patterns or factors that are common to many different types of activities. This has led to the proposal that resilient performance in general can be seen as based on four potentials: the potential to respond and intervene, the potential to monitor, the potential to learn, and the potential to anticipate (Hollnagel 2009, 2017).

The four potentials can also be recognized in the five factors described by this study. "Planning and preparing" are necessary for the potential to respond and do themselves require the potential to learn. "Briefing and (safety) assessment" are also necessary for the

potential to respond and are a natural complement to "planning and preparing." "Coordination, communication, and cooperation" are essential for good operations since they provide the basis for the effective balancing of demands, constraints, resources, and opportunities without which daily operations would be impossible. They are necessary for the potential to respond, but do also depend on effective monitoring of how the situation develops. "Proactive behavior" is not only strongly related to the potential to anticipate but can in practice probably be seen as synonymous to it. Finally, the "adaptations, adjustments, and corrections" represent the necessary qualities of the potential to respond.

The result of planning, preparation, briefing, and assessment communicated to the practical performers comprise an understanding of the task and the forces that affect their execution. The sudden storm that interrupts operations, the wire gliding across the sharp end of the anchor flukes reduces the strength, the anchor chain in full tension requiring attention form people on deck, etc. The knowledge of how the many elements onboard are interconnected and may interact with each other is needed to both correct and adjust performance to prevent dangerous incidents but also to increase productivity and facilitate acceptable outcomes. Taken together, the functions describe how performance is driven by and based on procedures, tradition, and habits. At different steps of the operations, each participant knows the general approach, work content, and the package around. How this is done represents continuity and predictability. The way to successful operations cannot be based on learning from failures and accidents alone, since that can only be used to prevent something from going wrong. Successful operations must be based on an understanding of how work goes well, and use this understanding to support and facilitate everyday operations—to make work truly resilient by sustaining the ability to function as required under expected and unexpected conditions alike.

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