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On Formal and Informal Factors: Enabling Learning for Safe Offshore Drilling Operations

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Traditional safety thinking has been concerned with investigating accident causations in order to learn from these. However, successful operations constitute the great majority of all the operations. It would thus be interesting to add a focus towards learning from operations that go well. The purpose of the current study is to identify factors that might contribute to successful operations in terms of safety. This purpose is approached by an empirical study consisting of 10 interviews with people who work on board a drilling rig currently operating in Norway. The informants who participated in the interviews hold different positions and come from different companies represented on board the rig. The findings in this study show that it can be difficult to characterize or define successful operations. The definition will be subjective; however, there are some common features of successful operations. Maintaining the life and health of people are the number one priority. A successful operation should also result in the intended product even though it might take some more time than planned. A successful operation is created by many factors and conditions. This study identified 27 factors that might contribute to successful operations in terms of safety. A lot of the theory explaining successful operations focuses on informal factors related to humans and their actions. However, the findings in this study implies that there must be both formal and informal factors present.

Keywords: communication, organizational learning, management, offshore drilling, formal structure, informal structure

Introduction

Accident investigations and the study of factors that lead to failure are widely used for learning and improvement (Kjellén, 2000; Sklet, 2004; Drupsteen and Guldenmund, 2014). Experience feedback is one of the key principles in safety management, in which systematic learning from incidents is the one main method (Kjellén, 2000). Things that go wrong and create

major accidents draw a lot of attention from the organization, authorities, media and the public. Such events are often very visible and, in combination with negative consequences, it is no wonder they have such a big focus in our everyday life. However, one can agree that accidents and failed operations make up a very small part of all the operations that are performed in an organization (Hollnagel, 2009). Most of the time operations tend to go well. If there is so much to learn from the small proportion resulting in accidents and unwanted events, then there must be a large potential for learning from the opposite side as well. This new way of thinking shifts the focus toward all the things that go right in order to understand normal operations and everyday performance. We use our knowledge about accident causations and contributing factors to accidents in order to prevent it from happening again. By gaining knowledge about the contributing factors leading to success, we can learn from successful operations as well. Few empirical studies have been published so far on learning from successful operations and from the factors that lead to success.

The purpose of this article is to present the results of an empirical study performed with the aim of identifying those factors that contribute to successful operations in terms of safety. The research question of the study is thus: *what factors contribute to successful operations in terms of safety?* This research question was answered by performing and analyzing interviews of people working at an oil and gas drilling rig operating at the Norwegian continental shelf.

Offshore drilling operations in the oil and gas industry are an interesting field of study when it comes to successful operations because of their complexity, association with high risk activities and the number of actors involved. Drilling operations have many stakeholders, all the way from the operator who will profit from the findings of oil and gas to the fishermen whose livelihood will suffer in the case of pollution. Accidents in the offshore oil and gas industry have the potential for severe consequences and it is in everyone's interest to ensure successful operations in terms of safety. Drilling of a well can be performed with several different techniques and by many different offshore installations or types of drilling rigs. However, the basic drilling system will overall be the same. Very simply explained, a hole is drilled in the ground at the seabed by a rotating drill bit. Torque is transferred from a power source through a drill string. The use of a drilling fluid that is pumped down the drill string helps transport the cuttings, which are the product of the drilling up to the surface. The drilling fluid will also function as lubricate and cool the bit. In order to control the pressure, one can adjust the weight of the drilling fluid. In addition, there is a blowout preventer (BOP), which can seal off the well if there is a 'well kick' that upsets the balance of the system (Jahn, Cook, & Graham 2008). Even though

it all sounds quite straightforward, there are a large number of things that have to be considered during the drilling of a well. We are referring to highly flammable substances under pressure. Not only is a hole being drilled in the ground, but the ground in question is placed up to several hundred meters under the ocean surface, which can cause challenges related to currents and weather conditions. There are several different actors involved in the drilling from different companies. One can define these operations as quite complex, with many different components affecting each other, and large amounts of energy involved.

Normal and Successful Operations

This view of success seems to be implied when Hollnagel (2013) argues that much more data will be available if we turn from looking at 'what goes wrong' to looking at 'what goes right.' This criterion does not necessarily distinguish between operations that are accident-free due to 'pure luck' and operations that are accident-free due to excellent safety work. An organization may experience a prolonged accident-free period even during the incubation period before a major accident (Turner & Pidgeon, 1997). The incubation period is characterized by danger signals that pass unnoticed or are misunderstood.

HRO (High Reliability Organisations) researchers argue that certain organizational properties and practices make an organization prone to success when it comes to safety. Early studies of HROs addressed complex systems that delivered remarkably reliable performance, such as aircraft carriers (Rochlin, LaPorte, & Roberts, 1987; LaPorte & Consolini, 1991), nuclear submarines (Bierly & Spender, 1995) and nuclear power plants (Schulman, 1993a). All these organizations can be termed as machine bureaucracy (Mintzberg, 1979) and as high risk organizations, according to Perrow (1984). Early accounts of successful performance include use of *redundancy* to derive highly reliable performance from imperfect human beings (LaPorte & Consolini, 1991), a capacity of the organization to *reconfigure spontaneously* during crises (LaPorte & Consolini, 1991); the emergence of a collective mind through *heedful interrelating* (Weick & Roberts, 1993), the successful *exploitation of slack,* including conceptual slack and the right to veto decisions (Schulman, 1993b), and *cultures of requisite variety,* facilitating information flow (Westrum, 1993).

Contributors to the emerging field of resilience engineering have insisted on the need to account more symmetrically for successful adaptations and accidents (Hollnagel, Woods & Leveson, 2006; Woods, 2006; Hollnagel, Pariés, Woods, & Wreathall, 2011). They have also argued that it is necessary to learn from normal operations in order to maintain and improve safety in systems that experience very few accidents. Normal operations

Table 1 Position of Informants

Mudlogger	Senior Cementer
Senior Toolpusher	Roughneck
Subsea Section Leader	Roughneck
Technical Section Leader	Rig Superintendent
Driller	Company Man

Table 2 Experience of Informants

Years of work experience	Number of informants
Less than 10 years	2
10–20 years	4
More than 20 years	4

will always involve variability, and the study of safety requires the study of normal variability.

Successful operations may encompass handling of serious disturbances. Studies of operations where situation control has been successfully regained and a dangerous sequence of events stopped are, therefore, also of relevance to the understanding of successful operations. Reason (2008) discussed cases of 'heroic recovery,' where human interventions have prevented disasters. Reason argued that Weick's notion of *collective mindfulness* needs to be complemented by a notion of *individual mindfulness.*

Method and Analytical Framework

Data Collection

This study is based on a case study design (Yin, 2009), based on drilling operations on a rig currently operating in the Norwegian sector. This rig has been operating internationally in several other places in the world. The rig was recently brought to Norway to drill in the Norwegian sector.

The case was conducted through qualitative research interviews. People in different positions have been interviewed to ensure as wide a range of perceptions as possible. People's point of view might vary depending on their position and type of work and responsibilities. Seven out of the ten interviewees came from the rig contractor company, one person was from the operator company (Company Man) and the senior cementer and mudlogger were employed by a third party service companies. The majority of the informants come from the rig contractor company because they represent the largest group on board the rig compared to the service companies. There are only a few people representing the operator company on board, so the operator company is very well covered.

The purpose of the interviews was to gather empirical data in order to answer the research questions. All the interviews were conducted over a

period of four weeks. The interviews lasted from 30–60 minutes. Some of the interviewees were at home while others were at work on the rig. Due to practical concerns, the interviews were conducted by telephone. Telephone interviewing can make it difficult to create the same relation and interaction between the interviewer and interviewee, as if they were face-to-face. It will also make it impossible to observe or use body language. That said there is no definite evidence that interviewees will answer differently in a telephone interview compared to a face-to-face interview (Bryman, 2012). The interviews were semi-structured. An interview guide with certain topics and questions was used. However, the interviewer was not very conservative with respect to this guide. A semi-structured interview allows the interviewee to talk about topics besides the questions in the interview guide and the interviewer will often ask new questions related to this. The topics and questions in the interview guide may not be asked in the exact order they were written, however most often all the topics will have been touched upon by the end of the interview (Bryman, 2012).

The interview guide was developed by the research team and consisted of 6 main topics with subsequent questions: background information about the interview object; the reasons why the rig had not experienced a major accident; assessment of success of operations; explaining success; and learning from success. The questions were developed on the basis of different theoretical perspectives addressed in two research workshops.

Nine out of ten interviews were recorded. Recording the interviews can be a great advantage, as it gives the opportunity to collect every bit of data provided by the interviewee. In the tenth interview the recorder was not operating. However, this was discovered immediately and the interviewer sat down with his notes and produced an extensive summary. Bryman (2012) point out that concentrating on taking notes in parallel while interviewing might distract the interviewer and make it difficult to catch important information given by the interviewee. Even though recording can be very useful, it is important to bear in mind that this could affect the interviewee's responses. People can be less open and more self-conscious when they know they are being recorded (Bryman, 2012). The recorded interviews were transcribed in full, word by word by one of the authors.

Data Analysis

Thematic analysis was adopted to study the interview material. This is a method for identifying, analyzing, and reporting patterns (themes) within data (Braun & Clarke, 2006). In contrast to other types of qualitative analysis, such as grounded theory, Interpretative Phenomenological Analysis (IPA) or discourse analysis, thematic analysis is not bound to a theoretical or epistemological framework (Braun & Clarke, 2006). Thematic analysis is

performed through several steps, and can be summarized in that the data is taken through the process of coding to establish meaningful themes. The actual analysis is not a linear process in the sense that the analyst goes back- and forwards between the data and the codes, as well as between the themes and the codes. Our analytical approach was driven by the researchers and theoretical interest in relation to the research question, and can therefore be classified as a deductive thematic analysis or a 'top down' way (Braun & Clarke, 2006). Both the coding and the theme development were thus driven by the research question. The codings were applied as was appropriate to describe, or capture, the essence of a segment in the data, like a sentence or a paragraph. This process involved a minimum of abstraction. A theme was defined according to Braun & Clarke (2006) as 'something important that relates to the research interest, and represents some level of patterned response or meaning within the data set' (p. 82). In this regard, constructs that embraced a number of initial codes, and in this way were mentioned by a number of interviewees, were identified as a theme. During the process of theme development, themes were continuously revised, meaning for example that some themes would be subdivided and others would be combined with the purpose of fitting the data. This step of the analysis involved therefore more interpretation. A digital mind map was applied to assist the analysis. On the last phase of the analysis, after finding the themes from the study, the themes were analyzed in accordance with Schiefloe's (2013) Pentagon model, which is a framework for analyzing organizations.

Theoretical Framework

A framework for analyzing organizational behavior was used to categorize and analyze the identified factors for successful operations. The framework is the so-called Pentagon model, developed by Schiefloe (2013) for analyzing organizations. Among other things, it has been used to perform a root cause analysis of the major gas leak on the drilling installation Snorre A in 2004 (Schiefloe et al. 2005), an incident that had been characterized as one of the more serious incidents at the Norwegian continental shelf in the recent years. The gas leakage did not cause any fatalities or cause a major environmental disaster, but could have been a disaster with only a few changes, as claimed by the Petroleum Safety Authority of Norway (Brattbakk, Østvold, Van der Zwaag, & Hiim, 2005). The Pentagon model can also be utilized to examine normal situations (Schiefloe, 2013).

The Pentagon model can be used on different organizational levels, from individuals to the general organizational structure. As the name implies, the Pentagon model involves five aspects that affects safety critical work in an organization (Schiefloe, 2013):

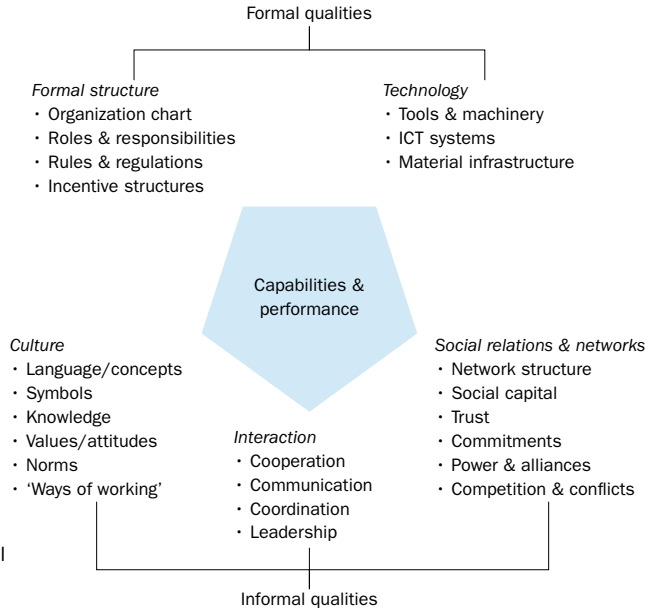

Figure 1
The Pentagon Model (adapted from Schiefloe, 2013)

- *Formal structure* is often described as 'organization' or 'organizational factors.' This includes roles and responsibility, authority, procedures and regulations and staffing, among other things related to the formal structure of the organization.
- *Technology* includes all the tools, machinery, equipment, ICT-systems and material infrastructure that the employees use to do their work. Maintenance, operating routines and the equipment's condition are also relevant for the technology aspect. Technology has to been seen in relation to a formal structure, as different types of technology and equipment have different requirements regarding procedures and management, and the other way around.
- *Culture* includes factors as language, values and norms, attitudes and habits, competence/knowledge, symbols and expectations on how the work shall be done. The aspect of culture covers what people understand, know, think and believe.
- *Social relations and network* covers the information structure, network structure and social capital in the organization. It tells us something about the relationship between individuals, but also between groups or alliances. Keywords here are trust, friendship, sharing of knowledge and experience, alliances and power, competition and conflicts.
- *Interaction* is about how the people in the organization communicate,

cooperate and coordinate. People adapt, interact and influence each other. This aspect included leadership and information flow. Interaction is a precondition for social relations and network, and a foundation for organizational culture, learning and transfer of experiences.

It is important to consider all of the aspects as dependent on each other to a greater or less extent. Changes in one of the aspects can have impact on the others (Schiefloe, 2013). By considering all of these aspects when studying an organization or an event, such as an accident, one can get a better understanding of the 'bigger picture.' It can also be a great help for sorting and systemizing information.

As indicated in Figure 1, the five factors can be divided into two main groups: formal qualities (formal structure and technology) and informal qualities (culture, social networks and interaction). This divide reflects the dialectic between formal and informal perspectives of an organization that has been emphasized by others, e.g. theory-in-use vs. espoused theory (Argyris & Schön, 1996), and bounded rationality vs procedural rationality (March & Simon, 1958). Lately, the same mind-set has been applied for discussing compliance to safety rules or adaption to the situation by Hale and Borys (2013).

Results and Discussion

What Are Successful Operations?

One of the questions in the interview was: 'What are successful operations in terms of safety?' When asked about their interpretation of a successful operation, the answers from the interview objects vary a lot, this reflects the subjective nature of this question. However, there are some common features in most of the descriptions. One of these common features is the absence of accidents or injuries to people. Another one is no problems or damage to the equipment. Several do also describe a successful operation as when everything goes according to plans and one is able to do what was intended and to deliver the intended product. One says that it is a success when everything goes according to plans, even though it might take longer in order to do it safely. Two of the informants emphasize that a successful operation can consist of many smaller operations, and that one big operation can be successful in the end even though there might be troubles in some of the smaller operations.

One person mentioned that a successful operation should have some flow. This does not mean that it needs to go too fast, but at least it should have some flow. However, he also stated that there can be challenges related to such a flow. If you are in a 'flow zone' for too long, you risk losing some of your focus because you enter a sort of comfort zone. He believes that accidents often happen in this kind of situations when you have your

Table 3 Contributing Factors for Successful Operations

Taxonomy*	Findings in the case
Culture and working environment	· Everyone can provide input, make suggestions and ask questions. · Good culture among everyone with mutual respect, openness and dialogue. · Good working environment
Interaction, communication, coordination and leadership	· Give people meaningful responsibilities. · Good communication and co-operation. · Working as a team and working for a common goal
Social relations and networks – human factors and skills	· Good understanding and knowledge about the operation, work and rig. · Understanding the bigger picture. · Being practical and focus on solutions. · Everyone can provide input, make suggestions and ask questions. · Involve everyone, from the newest and youngest from the most experienced. · Experience, both from previous situations and from your colleagues. · Working as a team and working for a common goal. · Trust your colleagues and the quality of their work. · Working with the same crew and people you know help build good routines. · Meet on the free time
Formal structure and organizational factors	· Having a plan B. · Thorough planning. · Plan and think ahead and anticipate what might happen. · Good procedures. · Good reporting. · Evaluation of the job, both before and after. · Little time pressure: focus on performing the operation properly and safely, even though it might take some more time. · Training and building competence. · Right people on the right place. · Support from the operator company. · Flat organizational structure
Technology factors	· Correct equipment. · Daily maintenance of equipment

Notes * From Schiefloe's (2013) Pentagon model.

guards down. In order to prevent this from happening and still maintain the flow, they try to rotate among different work stations.

Factors Contributing to Successful Operations

When analyzing the interview transcriptions, 27 contributing factors to successful operations were identified. These are presented in Table 3. The informants were asked to mention some factors that they thought could contribute to successful operations. In addition, some of the factors were identified from the answers to other questions in the interview. The factors

were categorized according to Schiefloe's (2013) Pentagon model. This categorization reveals that the majority of these factors belonged to the group 'Social relations and networks' and 'formal structure.' In the following, the findings are sorted based on Schiefloe's (2013) taxonomy. Then the individual findings are elaborated and discussed.

Culture and Working Environment

In an environment where everyone can provide input, no matter how little, it might be easier to convert tacit knowledge into explicit knowledge. Good dialogue and involvement can help individuals share their tacit knowledge. Encouraging questions can also help reveal some of this knowledge. As described by Jacobsen & Thorsvik (2007), individuals do often lack awareness of the knowledge they utilize and questions from colleagues might make them reflect more on this and find the right words to describe it. An environment where everyone can provide input, resembles HRO, e.g. in the aviation industry, where a co-pilot can give suggestions to the captain and even correct his actions (LaPorte & Consolini, 1991).

Good Culture among Everyone with Mutual Respect, Openness and Dialogue

Respect for each other's field of expertise and work responsibilities is important to maintain a good dialogue and teamwork. It seems like the crew on board this rig has acknowledged that everyone has an equally important role and that everyone's work are equally important to achieve a successful operation, both in terms of safety and efficiency.

Good Working Environment

A couple of informants spoke of the shift scheme, where they work one week on a daytime shift and one week on a night shift. This scheme implies a very abrupt transition, which they thought had a negative effect on people. As one of the informants pointed out, most people's bodies need time to adjust to this transition. Little sleep and fatigue can be considered a performance shaping factor as described by Flin, Wilkinson, and Agnew (2014). One can argue that enough sleep and rest help people stay focused, increasing their level of attention and thereby decreasing the number of mistakes. Good working conditions might also make people more receptive to learning. Everyone should feel responsible for creating a good working environment both for themselves and for their colleagues.

Interactions, Communication, Cooperation and Leadership

Give People Meaningful Responsibilities

This factor is related to leadership. Allowing people to work with something they feel good at and to make full use of their skills can be a motivational

factor. This also goes for having meaningful responsibilities. One of the informants said that his supervisor was very good at giving him responsibilities and allowing him to try for himself. The supervisor was always there to support and guide him, but he did not 'take the work out of his hands,' as he described it. Meaningful responsibilities will make people feel appreciated and perhaps they will focus more on the safety aspects of their responsibilities as well.

Good Communication and Cooperation and Working as a Team and Working for a Common Goal

Working as a team is one type of cooperation, therefore (22) and (23) are discussed in the same paragraph. Both teamwork and cooperation are two of the CRM skills described studied by Flin et al. (2014). Well-functioning communication and cooperation seems to be crucial for successful operations. One of the informants emphasized that the communication should be clear and easily understood without any room for ambiguity. The fact that there is a relatively flat organzsational structure on board that facilitates close dialogue makes a good foundation for communication and good cooperation across disciplines. There are no A-team and B-team, and the focus is on involvement. Working for a common goal that is in everyone's best interest can make people feel stronger relations to their colleagues and this will perhaps further enhance communication and cooperation. As described by Schiefloe (2013), interaction is a pre-condition for social relations and network, and a foundation for organizational culture, learning and experience transfer.

Social Relations and Networks: Human Factors and Skills

Good Understanding and Knowledge about the Operation, Work and Rig

The understanding and knowledge about the operation, work and rig constitutes a foundation for several of the other factors. This is particularly important in order to see the bigger picture and when establishing plans. One of the informants mentioned that everyone should have an understanding of the upcoming operation, how it is planned and what challenges they might encounter. It will also be important that people are motivated and self-confident enough to use their knowledge and competence.

Understanding the Bigger Picture

Understanding the bigger picture is about mindfulness. According to Weick and Sutcliffe (2007), mindfulness can be explained as the ability to see the bigger picture. This ability could be central in the process of a successful operation. Today's complex systems consist of many activities, components and conditions that are dependent and interact with each other all the time.

In order for the operations to go well, good knowledge of these interactions is required and one must therefore always have the big picture in mind. Mindfulness also represents the concept of resilience in the way that resilience seeks to anticipate future situations and to monitor ongoing developments as a way to be always prepared for what comes next. On the other hand, it will probably be impossible to be aware of all the possible interactions and combinations all of the time. In situations where one has not been able to foresee certain interactions and unexpected situations occur, the ability to respond becomes important. Unforeseen interactions and unexpected developments do not necessary lead to an accident; it could just as well have no negative consequence at all. It is important to have the ability to determine if unexpected developments are a warning sign or not. This is all about knowing how and when to respond. The ability to understand the bigger picture might also be a motivational factor. One might be more motivated and feel a different ownership towards the job if you feel that what you do is an important contribution to a bigger product.

Being Practical and Focus on Solutions

'If you have a problem, do not create another problem. Solve the first problem before you go on.' These are some wise words from one of the informants. Being practical and focus on solutions are central features when facing challenges and especially new, and perhaps unknown, challenges. Dealing with one problem at a time, if possible, can prevent the situation from becoming more complex, thus it will be easier to foresee interactions and keep track of the bigger picture. Several of the informants emphasized that, if a challenge or problem occurred, the operation could be stopped and everyone involved met together and discussed possible solutions. This kind of collective brainstorming seems to be very helpful for the crew. Not only do they more easily solve the problem, they also facilitate the opportunity to learn from colleagues and their ideas. This can help increase the overall level of knowledge in the crew.

Everyone Can Provide Input, Make Suggestions and Ask Questions

This bears witness of the good and informal relations among the crew. Schiefloe (2013) has described sharing of knowledge and experience as a key word for Social relations and network.

Involve Everyone, Form the Newest and Youngest to the Most Experienced

One of the informants is particularly concerned with the involvement of the newest and the youngest. He says that they can often see things that the more experienced do not notice. This could be things that the more experienced do not reflect upon simply because they are used to it, even

though it might have a big potential for improvement. One informant did also mention the dangers related to very frequent routine operations and the flow that comes with such operations. If one has done the operation a hundred times, one might become a bit 'blind' and a new pair of eyes can therefore be most helpful. To involve the newest and the least experienced on board are also important for learning and for building competence. This is an example of exploitation March (1991), in the sense that knowledge is transferred from the more experienced to the less experienced.

Experience, Both from Previous Situations and From Your Colleagues

In several of the interviews, experienced and skilled people came up as a prerequisite for success. Experience from previous operations and with the equipment will probably increase the ability to catch early warning signals and to find solutions, cf. the ability to respond and monitor in resilience (Hollnagel et al., 2011). Andresen, Rosness, and Sætre (2008) do also argue that a high level of competence and experience may increase the operator's ability to detect unwanted and unforeseen developments at an early stage. The informants described a core of very experienced leaders on board. These leaders can be a very good resource for experience transfer and learning for the people with less experience. It was described by the informants that everyone's opinion was equally respected regardless of experience. All the knowledge, both silent and explicit, and experience of the crew on board can be considered one large experience database. It is important to have mutual respect for each other's competence, to see the value of your colleagues' experience and to use this as a resource in planning, decision-making and problem-solving.

Trust Your Colleagues and the Quality of Their Work

One of the informants described a situation where the driller would choose to stop the operation because he did not feel that everything was ok. Even though there was no indication of anything wrong the company man and the senior toolpusher would respect and support the driller's decision. The operation would be stopped and they would check for problems. Even though sometimes it turned out that everything was in fact fine, the others would never criticize the driller's decision. This does again illustrate the 'better safe than sorry' policy on board.

Working with the Same Crew and People you Know Help Build Good Routines/Meet on the Free Time

Several of the informants said that working with the same crew and people you know was a great enrichment for the operations and work itself. Working in a fixed crew helps build good working routines and create an effective

team. It is also directly linked to a good working environment, where people trust each other and feel confident in their roles. One of the informants expressed a wish for more social events on the free time on shore. He felt that such events or team building would further facilitate good and efficient working routines. Team building can also help develop social relations that might contribute to a greater sense of responsibility for your colleagues. People caring about each other and looking out for each other might improve the level of safety. Skjerve (2008) has described robust work practice as the following: e.g. when a person notifies a colleague who is about to do something wrong that can lead to negative consequences for him or others. It requires good, well-established relations and trust to be able to tell a colleague that he or she has made, or is about to make, a safety critical error. One must be able to trust each other and do not take offense when someone points out an error or mistake. The finding is in accordance with HRO thinking (Rochlin, LaPorte, & Roberts, 1987; LaPorte & Consolini, 1991).

Formal Structure and Organisational Factors

Having a Plan B/Thorough Planning/Plan and Think Ahead and Anticipate What Might Happen

Thinking ahead and anticipate what might happen is one of the four pillars of a resilient system, the potential (Hollnagel et al., 2011). This could also be recognized from Schiefloe's five prerequisites for safe operation, which describes a reliable organization as one that makes use of good planning and risk assessment (personal communication with P. M. Schiefloe, as cited in Albrechtsen, 2012). Størseth, Albrechtsen, and Eitrheim (2010) have described risk awareness as one of the Contributing Success Factors (CSF's). This includes the adaption process in resilience engineering: Anticipation-Attention-Response (A-A-R). Planning and anticipation of future events have a central role in this process.

It is reasonable to believe that the range and variety of the potential events one will be able to anticipate are related to previous experience and knowledge and so will the sensemaking, should such an event occur. Clegg, Kornberger, and Tyrone (2008) have described seven characteristics of the sense-making processes; one of these characteristics tells us that the processes are retrospective in the way that people make sense of things by interpreting present situations in the light of the past. However, it is important to 'look outside of the box,' and not to rely solely on own experience. A broad specter of knowledge and experienced people will help improve planning and anticipation. A plan B will be a result of some kind of risk assessment, job evaluation or anticipation process. This would be a way of ensuring that the crew knows how to respond if irregularities occur, cf. the four pillars of Resilience (Hollnagel et al., 2011). A plan B can be prepared

on different levels. It could be specified as part of the original plans, but it can also be less specific actions that are based more on the ability to be flexible, adapt and improvise. Some of the informants talk about thorough planning as an important factor for success. Here one can draw parallels to the Efficiency-Thoroughness trade-off (ETTO) as described by Hollnagel (2013). According to the ETTO principle, there must be a minimum level of both efficiency and thoroughness in order to succeed with an operation. However, it will be impossible to maximize both at the same time (Hollnagel, 2013). It seems like the organization on board this rig has found a well-functioning balance between efficiency and thoroughness as reported in this study. They continuously work to improve efficiency, but never at the expense of safety. One might get the sensation that this is an organization that favors thoroughness above efficiency pressure.

Good Procedures

Procedures are important not only as a means of fulfilling laws and regulations, but also as a fundament creating a certain common standard in all the operations. A well-functioning structural fundament can be important to have success. One of the informants pointed out that not all the procedures are as easy to follow in practice. He believed these procedures were often written by people on shore who did not have the adequate knowledge about how the work should be actually done. A good procedure should have a professional foundation, serve the purpose and be pedagogically good. It is essential that the user can understand the value of the procedure and why procedures are needed. One way to obtain this can be to make people feel ownership towards the procedures. On this rig, the culture is characterized by openness and involvement, where everyone can make suggestions. This might help facilitate people's involvement in the writing and editing of procedures. Even though it might be crucial with a structural fundament of procedures, one must keep in mind that too rigid procedures might leave little room for adaption and flexibility.

Good Reporting

Reporting of not only unwanted, but also wanted incidents can contribute to learning from things that go well. In order for people to appreciate the opportunity of reporting, it is important to give response and to discuss the reported incidents. Good reporting is not only about having a high number of reports, but also about having good quality (Kjellén, 2000).

Evaluation of the Job, Both before and after

Evaluation before the job starts would be a part of planning and risk assessment. Pre-job meetings and pre-job evaluations are rather common

and often embodied in procedures. Debrief or evaluation after the job is perhaps more uncommon. One of the informants stated that they do have debrief meetings on board the rig, but this does rarely involve everyone that contributed to the job. Another informant mentioned that debriefs are most common after operations where something did not go according to plan. More focus on debriefs also after successful operations might contribute to learning from things that go well. Resilience tells us to make use of learning not only from previous accidents and failures, but also to draw knowledge from success and normal operations (Hollnagel et al., 2011).

Little Time Pressure: Focus on Performing the Operation Properly and Safely Even Though It Might Take Some More Time

The overall impression is that there is little time pressure or pressure related to increasing efficiency on this rig. According to the informants, this also applies for the rest of the Norwegian sector. This does not mean that they do not focus on improving efficiency: they do always have this in mind and are continuously working on finding new and more efficient ways to perform the operations and avoid down time. However, the main focus seems to be on performing efficient, high quality operations without compromising the level of safety. Several of the informants did also emphasize that this trade-off was supported by both the land organization and the operator company. According to Rasmussen's model of drift, both management efficiency pressure and the effort to avoid unacceptable workload can steer the operation towards the boundary of acceptable risk (Rasmussen, 1997). Being able to minimize this pressure to an acceptable level can therefore be essential for safe work. What the acceptable level of pressure is will most likely vary between different operations. It will probably be more acceptable to try optimizing the efficiency in routine operations than in more challenging and less frequent operations or critical phases. Flin et al. (2014) have described stress as one of the performance shaping factors: the low time pressure on board contributes to a low stress level and can therefore increase the level of high quality work performances.

Training and Building Competence

Training and building competence are directly linked to experience. One of the informants pointed out that it is important that everyone learn how things are done and how the procedures are to be followed, and that everyone get the same prerequisites for learning. He emphasized that 1:1 training can impair the quality of the competence. If number one teaches number two, number two teaches number three and so on, you risk that number nine in the row might be 'lazy' and only pass on the shortcuts to number ten. Several of the informants mentioned that Norwegian offshore employees represent an overall high standard in competence. The profes-

sional status is raised through formalized education and training of good quality. A high level of competence, skills and knowledge will make the operator more prepared to handle unwanted and unforeseen situations. Competence and experience might help compensate in situations where there is no procedure or clearly defined prescription on how to act (Andresen et al., 2008).

Right People on the Right Place and Right Time

To have the right people working on the right place could be just as important as using the correct equipment. Allowing people to work with something they feel good at and to make full use of their skills can be a motivational factor. This is also an aspect of planning and resource management.

Support from the Operator Company

As a contractor company, the operator will be your client. The operator company makes the drilling program and will often be on top of the decision-making. It is therefore very important for the contractor and the crew on board that they have support from the operator, especially the company man who is the operator company's main representative on board. The informants say that the operator company support the favoring of little time pressure and high focus on performing safe operations above efficiency pressure. One of the informants emphasized that the company man was part of the great team and there was no 'them' and 'we.'

Flat Organizational Structure

A flat organizational structure implies that decisions are made on the lowest possible level of the organization, as near the sharp end as possible. Proximity to the operation will be an advantage. As pointed out by one of the informants, procedures and work routines are often written by people on shore who do not have a full understanding of the operation in question. This can make it difficult to follow the procedures. Flat organizational structure does also imply short communication routes and it is therefore less likely that messages are misunderstood. It seems like the leaders are good at delegate decision-making without pulverizing of the responsibility. Such an organizational structure will make it easier to build relations across different levels and it could thus be easier to give a heads up or to make new suggestions.

Technological Factors

Correct Equipment/Daily Maintenance of Equipment

The use of correct equipment can be linked to the planning phase of an operation. One of the informants pointed out that they always tried to prepare

Figure 2
Factors That Might Contribute to Successful Operations in Terms of Safety

all the equipment they needed before the operation started and it was important that they knew exactly where to find the equipment needed. Maintenance of equipment can be seen as an act of proactivity. Maintenance and testing of e.g. the BOP are performed to prepare for potential unwanted events. The bigger picture does also play a role in maintenance of equipment: 'It's important to keep the details in mind as well, but we often see that it's the basics that's lacking. Like basic maintenance and such,' an informant stated. Technical aspects did not come up as a very significant topic in the interviews. However, it was briefly spoken of in relation to some of the other topics.

Conclusion

Due to the complexity of drilling operations, it might be difficult to explain exactly what is causing it to go so well. It can be hard to pinpoint because people might not know the exact reasons. Things that go well have not been the focus of traditional safety thinking, and people and organizations are not used to reflect upon the causes behind success. Just like accidents are rarely caused by only one reason alone, successful operations are the result of multiple conditions and factors. The factors are also clearly interrelated.

Figure 2 illustrates how the factors contributing to successful operations are divided into five groups. There is not necessarily always a clear distinction between formal and informal factors: some might belong in both categories. Formal factors might also be a prerequisite for informal factors

and the other way around. Some of the groups in the figure are bigger than others to illustrate the distribution of factors among the five groups. The group of 'technology' is the smallest one. However, this does not necessarily imply that technological factors are less important than others. It seems like the informants had a greater focus towards the other four groups.

When explaining successful operations in terms of safety, the literature mainly focuses on informal factors related to humans and their actions (e.g., LaPorte & Consolini, 1991; Weick & Roberts, 1993; Westrum, 1993; Hollnagel, 2009; Hollnagel et al., 2011). Despite this, the empirical findings in this study do clearly indicate that both formal qualities and informal qualities must be present in order to create successful operations. It can seem like the informants are more oriented towards compliance to rules than informal qualities like adaption to situations. Some of the informants say that good procedures, reporting and following routines are important to avoid major accidents. At the same time, the informants describe a flat organizational structure and a type of leadership that is not consistent with compliance and a top-down approach. This might imply that both compliance and resilience are equally important for successful operations and that a certain degree of both are required.

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