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Risk analysis and risk management approaches applied to the petroleum industry and their applicability to IO concepts

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ABSTRACT

Due to changes introduced by Integrated Operations (IO) it is possible that traditional risk analysis and risk management approaches in the oil and gas industry are also challenged. In this paper we study the impact on these approaches by asking two questions: (1) what methods for risk analysis are used in the Norwegian oil and gas industry? (2) What are the risk analysis and risk management challenges in an IO context from the perspective of actors in the Norwegian oil and gas industry? An explorative approach was chosen and the empirical findings are based on three separate studies: (1) a survey of risk analysis and risk management in different business sectors in the oil and gas industry; (2) qualitative interviews about the generation of knowledge for decisions that involve risk in an operating company; and (3) qualitative interviews of people working with risk analyses in different companies exploring their use of risk analysis methods. The four main results are: due to IO it is necessary to look for other inputs to risk analyses; establish suitable assessment approaches to human and organizational issues; develop resilience-based approaches for operational risk assessment; and, utilize IO to improve the risk management process.

1. Introduction and scope

While there are several definitions of Integrated Operations (IO) they all more or less explain the concept in the same terms. The IO Centre (2011) explains IO as 'the integration of people, work processes and technology to make smarter decisions and better execution. It is enabled by the use of ubiquitous real-time data, collaborative techniques and multiple expertises across disciplines, organizations and geographical locations'. Though IO now seems to be the established and most used denotation in Norway for this development, other names have also been used, e.g. Field of the Future (BP), Smart Fields (Shell), eOperations and eField. By implementing IO the industry aims to achieve extended operational lifetime, reduced costs and improved safety, production and recovery rates. IO however implies several changes compared to traditional operations where oil and gas production was almost totally managed by the platforms with little or no interaction with external parties. The boundaries of the system were easy to understand, as were the responsibility and management systems. With IO these boundaries are challenged and platform operation is no longer only a matter for the offshore organization. New information and communication technology (ICT), digital infrastructure and real-time data are being deployed to enable new work processes and the integration of processes and people offshore and onshore and between companies. Real-time data and information from offshore processes are thus made available and are used to monitor operations independent of geographical and organizational borders. In addition, IO also makes it possible to remotely operate and control some of the offshore systems and processes. The exchange of information over large distances without significant delay and use of high-quality collaboration technology connects different actors and increases access to expert knowledge.

The changes due to IO will have both positive and negative impacts on major accident risk. Major accidents are those with more extensive consequences than occupational accidents. Sundet et al. (1990) define an accident as 'major' if one of the following criteria is fulfilled: at least five fatalities, material damage exceeding NOK 30 million or major environmental damage. The definition is in line with PSA (2011) which explains a major accident as 'an acute incident, such as a major discharge/emission or a fire/explosion, which immediately or subsequently causes several serious injuries and/or loss of human life, serious harm to the environment and/or loss of substantial material assets'. Based on these definitions we can say that occupational accidents are less devastating in size and usually influence fewer people. The difference between a major accident and an occupational accident is not always clear. A major accident can also be an occupational accident with personnel injuries and fatalities to one or two people. Reason's (1997)

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explanation of organizational and individual accidents is another good illustration of the two types of accidents. Organizational accidents have multiple causes involving many people operating at different levels of the organization, often with devastating effects on uninvolved populations, assets and the environment. In individual accidents, a specific person or group is often both the agent and the victim and while the consequences to the people concerned may be significant their spread is limited. Perrow (1984) offered a similar explanation by distinguishing between system accidents and component failure accidents. System accidents involve the unanticipated interaction of multiple failures which may result in devastating accidents, while component failure accidents involve one or more components that are linked in anticipated sequences.

According to Skjerve et al. (2009) it is not expected that there will be essential differences in the potential hazards (oil/gas leakage, fire, explosion, collision, terror, etc.) due to IO, however there are changes in the factors leading to incidents and also the consequences of the incidents. Altogether the changes create new challenges as well as opportunities for risk analysis and risk management approaches. In this paper we study the impact IO has on these approaches by asking the following two research questions:

(1) What methods for risk analysis are used in the Norwegian offshore oil and gas industry?
(2) What are the risk analysis and risk management challenges in an IO context from the perspective of actors in the Norwegian oil and gas industry?

The questions are approached by three separate studies, one survey and two interview studies.

The paper starts by giving a general overview of risk analysis methods available (Section 2) as background information to the discussion. While Section 2 is general, the rest of the paper focuses on specific risk analysis and risk management approaches in the oil and gas industry and whether these are appropriate for IO. Section 3 describes the applied approach for each study and Section 4 summarizes the results from them separately. In Section 5 the results from the studies are collectively viewed and important findings discussed. The paper ends with the conclusions in Section 6. The paper is exploratory and the main scope is to present empirical data and results from the three studies. Thorough discussions of theoretical implications are not given.

The paper is written within the RIO (Inter disciplinary Risk Assessment in Integrated Operations) project, sponsored by the Norwegian Petroleum Safety Authority (www.ptil.no), the IO Centre at NTNU (http://www.ntnu.no/iocenter) and the PETROMAKS programme at the Research Council of Norway (www.forskningsradet.no/petromaks).

2. Overview of methods

There is already a range of methods and tools for risk analysis with different focus, strengths and weaknesses. A thorough overview is found in Everdij and Blom (2008) and FAA (2000). Examples of risk analytical methods for accident risk are given in Table 1. The grouping and characterization of methods are based on Øien et al. (2002), Sklet (2002), Grøtan and Albrechtsen (2008) and Rausand and Utne (2009). The selection criteria have been methods for assessing human and organizational factors, common methods used in the Norwegian oil and gas industry, methods developed in Norway and new methods. The methods are divided into subgroups with a short description (columns 1 and 2) and examples of methods (column 3). The abbreviations are explained after the table. Column 4 indicates whether the methods mainly focus on man (M), technology (T) or organizational (O) conditions. Column 5 gives the main application phase of the methods; design (D) or operational (O) phase. The operational phase is the production period where the installation is used to produce oil and/or gas. Regular maintenance belongs to the operational phase. Modifications are normally defined and carried out as design projects and methods used for such purpose are here categorized as D.

3. Approach

The empirical findings are based on three separate studies in the Norwegian oil and gas industry: (1) a survey about risk analysis and risk management in different business sectors; (2) qualitative interviews on the generation of knowledge[1] for decisions involving risk in an operating company; and (3) qualitative interviews of people working with risk analyses in different companies exploring their use of risk analysis methods. The survey was based on a structured questionnaire which gave the opportunity to collect answers from a lager selection of respondents and perform some simple statistical calculations. In the interview studies more open-ended interview guides were used which gave the opportunity to collect more nuanced and descriptive answers from a smaller selection of informants. In this section the research approach for each of these studies is described.

Hence, both qualitative and quantitative studies have been combined. There are clearly different strengths and weaknesses between qualitative and quantitative research, however by combining them they generate complementary knowledge. In this paper, the three studies are combined in two ways as described by Hammersley (1996): complementarity (each method produces different but complementary data about the same phenomenon) and triangulation (using data produced by different methods to validate each other). By such combinations, the validity of the results are strengthened and the possibility for transferability is improved (Thagaard, 2003). Risk analysis related to IO is an unexplored area of research. We have thus chosen an explorative approach by mapping how the industry interprets analysis and management of risk in an IO context. Interviews support this purpose as they generate knowledge in interaction with informants by collecting and interpreting the interviewees' perception of the world (Kvale, 1997). The results of these interview studies should not be seen as generalized facts. Rather, the results are interpretations of some actors' experiences of risk assessment and IO in their working context. By triangulating the interview results with a survey, generalization and transferability can be strengthened, as quantitative research aims at explanation and is theory-driven as opposed to qualitative research that is exploring and driven by defining concepts (Ringdal, 2001).

3.1. Survey about risk analysis and risk management

The survey had two parts: (1) exploring statements about risk analysis and risk management; (2) mapping the actual risk analysis methods used in the oil and gas industry. The first part was based on a literature review of risk analysis and risk management (Knudsen, 2010). The review included literature from the oil and gas industry as well as other industries, together with finance and project management. Statements about the strengths and weaknesses in risk analysis and risk management were identified and assessed for their relevance to the oil and gas industry. A total of 23 statements were selected as basis for the survey, and a five-point scale was used to examine to what degree the respondents agreed or

[1] The concept 'generation of knowledge' is based on Renn's (2008) basic elements of the risk governance framework. Generation of knowledge is found on the right-hand side (the assessment sphere) of this framework.