

REDEFINITION OF RISK IN NORWEGIAN PETROLEUM: RISK MANAGEMENT CONSEQUENCES

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In 2015, the Norwegian Petroleum Safety Authority introduced a new definition of risk, formulated as ‘...the consequences of activities with associated uncertainty.’ This paper explores how the new definition is understood in the industry and possible changes in risk management the change has led to in the Norwegian petroleum industry. Semi-structured interviews with seven operational decision-makers from operator companies in Norway were conducted to gain insight into their understanding of the new concept, and its implementation. Decisions were primarily based on available knowledge, including tools, analyses, industry experience, and joint assessments with experts. Sources of uncertainty highlighted by the informants included new technology, a lack of competence and knowledge, and external factors such as pandemics and global conflicts. Implementing the new concept of risk has increased awareness of the uncertainty dimension of risk and has led to the adoption of new tools and assessments. However, there is a need for further development of tools and methods to address the uncertainty dimension of risk across companies and actors. The study highlights the importance of communication and discussion between decision-makers and knowledgeable personnel for dynamic and effective risk management, and a shared understanding of risk is necessary for managing it effectively.

Keywords: the concept of risk, practical risk management, decision-making, Norwegian petroleum industry, uncertainty, risk communication, sources of uncertainty.

1. Introduction

In 2015 the Petroleum Safety Authority (PSA) reformulated the definition of risk. The traditional conceptualization involving likelihood and consequences was replaced with ‘...the consequences of activities with associated uncertainty’ (Petroleum Safety Authority, 2016). The redefinition was followed by different PSA activities (i.e., distribution of written material and industry workshops) to stimulate reflection and risk management practices that involved the consideration of uncertainty to a greater extent than before, as illustrated in Fig. 1. The figure illustrates how activities, uncertainty, and consequences are interrelated when it comes to risk.



Fig. 1. Diagram illustrating the relationship between activities, uncertainty and consequences in the redefinition of the concept of risk.

The figure includes three interconnected circles, each representing one of these factors from the concept. The Activities circle represents various decisions that could lead to potential risk.

The consequences represent various outcomes and impacts that could result from these activities and uncertainties, and the uncertainty circle is the degree of incomplete information and knowledge. This paper will consider changes in risk management after introducing the new definition and address the following research questions:

- How do decision-makers in the petroleum Industry understand the new definition of risk?
- How is uncertainty considered in decision-making processes?
- How has the new concept of risk impacted and been implemented into the risk management process?

Divergent understandings of the core concept of risk can create misunderstandings when communicating with other actors. The risk management process goes through several stages and involves several actors, and a shared understanding of the term is thus essential.

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2. Theoretical framework

The petroleum industry is complex, and there will always be uncertainty about which scenarios could lead to accidents. As surprises will occur, one might be unable to identify all relevant factors in risk assessments. Petroleum is a high-risk industry, which requires careful planning, judgment, and a good decision-making process for choosing reasonable solutions.

2.1. *The concepts of risk and uncertainty*

The introduction of the new risk concept started in 2013 for PSA, but ISO's standard on Risk Management in 2009 also addressed uncertainty in the concept of risk (Røyksund & Engen, 2020). A crucial part of understanding the impact of a new risk concept is knowing how risk impacts decision-making. There are multiple ways to define risk, but the most common is defining it as a function of probability and consequences (Rausand & Utne, 2009). Another approach is to describe risk as quantifiable through searching

and understanding risk through the questions (Kaplan & Garrick, 1981):

- What can go wrong?
- What is the probability?
- What are the consequences?

One tries to predict future events in specific activities or work operations by answering these questions. This helps create a risk picture useful for defining risk-reducing measures. In 2015 PSA redefined its definition of risk as the consequences of activities with associated uncertainty. According to PSA, handling uncertainty is about understanding the decision-making's limits (Petroleum Safety Authority, 2016). Uncertainty is the imperfect or incomplete information and knowledge about a hypothesis, a quantity, or an occurrence of an event (Aven et al., 2018). As uncertainty is a vital part of risk, it can often be associated with activities to be carried out. It is usually meant to relate to the uncertainty about future events. Uncertainty will always occur, in all assessments and decisions, as it is impossible to predict what will happen and how it will appear with its ripple effects. Complex systems, new technology, model uncertainty, parameter uncertainty, time pressure, and insufficient competence contribute to uncertainty (Rausand & Utne, 2009). Thus, uncertainty was also addressed in the ‘traditional’ definition of risk, but the redefinition highlighted uncertainty as an explicit dimension.

2.2. *Management of risk and safety*

Management of risk and safety involves decision-making. Risk management is a coordinated activity process to direct and control the organization with regard to risk (ISO, 2018). The process requires applying the information and knowledge available to assess the risk involved and take measures to reduce or remove the risk (Aven, 2015), and where all measures and activities related to risk are managed, assessed, and evaluated, which relates to the rational decision-making process in Fig. 2. Fig. 2 illustrates a simplified and schematic overview of risk management as a rational decision-making process. The underlying assumption on how risk is handled through risk management is that it is a continuous process between risk assessments of

activities and decisions and risk-reducing measures.

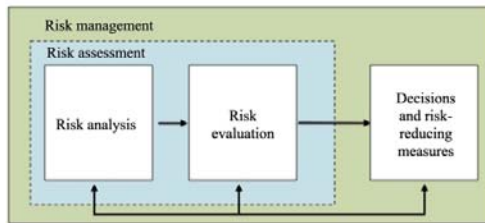


Fig. 2. Simplified and schematic overview of risk management as a rational decision-making process ((Kongsvik et al., 2018) p.113)

However, safety management is a continuous process of creating knowledge about expected levels of safety to make decisions about accident prevention measures. In the petroleum industry, safety management and risk management have distinct differences. While both are essential to ensure safe operations, safety management focuses on providing decision support to establish adequate measures for the organization's risk picture. This involves distributing safety information, decision-making processes, production systems, data collection, analysis, and storage. In contrast, risk management in the petroleum industry is concerned with identifying potential hazards, evaluating their likelihood of occurrence, and assessing their impact on the organization's operations, personnel, and environment. It involves developing strategies and implementing controls to mitigate risks and prevent incidents from occurring. Therefore, the petroleum industry's safety management and risk management serve different functions. Safety management provides decision support for establishing measures to address the risks identified through the risk management process.

2.2.1. Risk communication

Risk communication involves communicating risk and sharing knowledge and information about risk between decision-makers and others (Aven, 2003). The information can relate to various aspects of risk as probability, consequences, uncertainty, and handling, that are part of the decision-making basis.

Managers in an organization will often make decisions that can be understood as a result of communication between people with whom the manager relates. Thus, a decision process is seen as a product of information the manager has acquired, decisions made, and situational awareness (Eid & Johnsen, 2018). ISO 31000 describes risk management as a combination of communication and consultancy. This provides the stakeholders with an understanding of risk and the decision-making foundation. Communication promotes consciousness and understanding of risk, while consultancy obtains more information and knowledge to support decision-making.

2.3. Risk and uncertainty in the decision-making process

A fundamental cause of uncertainty is the lack of information and strength of the knowledge basis, and such conditions are important to consider in decision-making (Aven, 2009). Uncertainty arises when one does not know all the factors that can be of relevance in a decision-making situation.

2.3.1. Decision-making on different levels

In the petroleum industry, decision-making can be analyzed on four different levels; (1) planning- and execution decisions and (2) strategic and (3) operational decisions, and (4) decisions related to emergencies (Kongsvik et al., 2018; Yang & Haugen, 2015).

In this paper, we will focus on strategic and operational decisions. Strategic decisions have a long planning horizon; decisions on this level can affect risk in an entire organization. A long planning horizon (years or months) provides the opportunity to carry out comprehensive risk analyses and comparisons of alternatives. Operational decisions have a shorter time horizon (days or weeks) and are typically made daily in a system in operation. Decisions on this level can be related to the decision theories of rational choice and bounded rationality.

2.3.2. Risk-informed decision-making

Risk-informed decision-making is defined as decision-making approaches where data and insight from a risk assessment are considered together with other sources of information (Johansen, 2014). Decision-making must ideally be risk-informed and not risk-based, as risk

assessment contains several limitations and should not be used mechanically. Several sources of information should be available because the risk is not one isolated object (Johansen, 2014).

3. Methods

Semi-structured interviews were performed, as it seemed most appropriate to explore the research questions with a qualitative approach. Our primary objective was to gain a comprehensive and in-depth understanding of decision-makers in the petroleum industry. As decision-makers make different types of decisions, it was important to understand the topic comprehensively and the decisions the informants make in everyday life. A semi-structured interview is preferable to generate new theories and find more nuanced information with fewer informants available (Kvale et al., 2015). The study participants were recruited through personal networking. The informants were interviewed digitally (Teams). The interview topics were the redefinition of the risk definition, uncertainty in decision-making, and practical risk management. Seven informants from two different oil companies were interviewed. The informants were all decision-makers who participated in strategic and operational planning decisions where risk evaluation was a central part of the decision-making process. Thematic analyses were conducted to analyze the qualitative data from the interviews and fit the study based on its approach by identifying, analyzing, and reporting patterns in themes from a qualitative data set (Braun & Clarke, 2006).

4. Results from the interview

The empirical results will be presented in the following. The informants are decision-makers who work in the petroleum industry in different petroleum companies.

4.1. Redefinition of risk

Even if the word probability is removed from the definition, the assessment of probability will still be important in future risk assessments and analyses. Knowledge of the new definition among the informants varies, with three out of seven having no understanding of specifying the new risk concept. Although not everyone is familiar with the change, the uncertainty is still addressed, according to the informants. This could be indirect and direct assessments by asking

themselves critical questions and visualizing the uncertainty of activities they are to implement.

“I have not heard of the new definition, and it has not changed the way we, or at least I, have worked on it. [...] we are trying to find out, what is unknown to us? What is it that is indirect uncertainty.”

One of the companies had implemented a new tool to highlight and emphasize uncertainty. The informants participated in strategic and operational decisions in which risk evaluation was a central part of their decisions. The decisions were based on the available information, i.e., tools, analyses, and experience in the industry as well as a joint assessment with knowledgeable personnel. In the case of decisions that involved considerable uncertainty, special information gathering was carried out. The uncertainty was also highlighted in tools or described in the documentation.

4.2. Uncertainty in decision-making

The informants were involved in strategic and operational decision-making processes that often involved assessing risk. Their decisions were based on various factors, including tools, analyses, industry experience, and input from knowledgeable personnel. When faced with decisions that involved uncertainty, the informants would gather information and take steps to account for potential risks. Uncertainty was acknowledged using specialized tools or documented in official records. The informants identified various sources of uncertainty, including new technology, insufficient expertise, model uncertainty, and the potential consequences of decisions. However, they also noted that external factors posed a particular challenge. Ultimately, the board played a significant role in shaping the final decisions.

“[...] is it something new, is it something familiar, or is it something different, not different? And that review can be long or short, a little later what we are going to do, is it a known type of well? Blueprint of the previous one? Then it takes a short time. Is it a new type of well with a new element? Then it takes a little longer then, quite naturally really.”

4.3. Practical risk management

The study's findings revealed that understanding and conceptualizing risk influenced practical risk management. As a result of the new risk definition, new tools were developed, and there was an increased awareness of the uncertainty aspect of risk.

“Everything from the understanding of what the job really entails, to the uncertainty around when the job will arrive is coming. Partly lack of competence for sure and I would say a good combination of a lot. The is again in a way what you don't know because you are at the forefront and that is what is so difficult catch up.”

One of the developed tools functioned as a prioritization tool, employing a line structure highlighted in a map similar to a risk matrix. This tool was unavailable to some informants, but they still addressed uncertainty during risk assessments. The study participants also noted that the new risk definition led to different methods of communicating risk. The PSA had shifted its focus toward the coherence of the risk management process from daily operations to overall risk management. This emphasis on coherence can be compared to the new concept of risk.

“We have changed our tools and are trying to remove that probabilistic thinking. We try to bring in the term uncertainty, and where that uncertainty comes from. You try to specify it and try to dig into it so that you really understand what it is.”

5. Discussion

This paper has examined how the new concept of risk introduced by the Petroleum Safety Authority Norway (PSA) in 2015 is understood and implemented among operational decision-makers in the petroleum industry. It has evaluated how uncertainty is considered in practical decision-making processes and how it affects the overall risk management process.

5.1.1. Understanding of the new concept of risk

The level of familiarity with the new concept among the informants varied, with three out of seven having no knowledge of the new concept of risk. However, uncertainty is still assessed through indirect and direct evaluations by posing critical questions and visualizing the uncertainty of activities to be carried out.

Implementing the new concept has

happened over time and is still under development. Although a new risk definition has been introduced, it does not mean that companies have moved away from the traditional approach to risk, which involves evaluating probability and consequences. The clarification has led some informants to incorporate the uncertainty dimension more explicitly in addition to the traditional risk approach. It is helpful to consider this dimension directly, as previous practices might have involved implicit or little consideration of uncertainty. According to the informants, uncertainty is primarily related to the knowledge base underlying the assessments.

A shared understanding of what is included in the term risk is essential. If there is a lack of shared understanding of risk, it can create misunderstandings among decision-makers. It is necessary to emphasize the strength of knowledge behind the decisions made, as understanding risk largely influences the decision-maker. The study shows that operator companies are concerned with creating shared knowledge and dealing with uncertainty from different sources.

5.1.2. Uncertainty in the decision-making process

In a world that is constantly changing, risk management will be essential. Therefore, a shared understanding of what risk means is necessary. Without a shared understanding of risk, misunderstandings among decision-makers can arise. Therefore, it is essential to emphasize the knowledge strength behind the decisions made, as decision-makers are primarily influenced by their understanding of risk. The operating companies involved in this study focus on creating a shared understanding and handling uncertainty from various sources.

The decisions by the informants in the study are characterized as risk-informed decisions. As in risk-informed decision-making, it is essential to consider uncertainty, combine interdisciplinary expertise, and implement the decisions transparently (Johansen, 2014). According to Vargas-Hernández and Ortega (2019), organizations face the challenge of making decisions that may not be optimal due to their need to adapt to the environment in which they operate. When organizations lack perfect information, have bounded resources, and are restricted in processing information, they may

exhibit bounded rationality and make decisions based on the available data, resources, and capacities. Results illustrate that the informants recognize the presence of uncertainty in decision-making and involve relevant personnel to provide a basis for high-quality decisions.

Sources of uncertainty that have emerged in the study and affect the decision-making process include external factors (from society and the world), model uncertainty, consequence and parameter uncertainty, inadequate expertise, and introduction of new technology. Uncertainty is handled and reduced by involving knowledgeable personnel and subject matter experts, and external suppliers. These contribute to increasing the knowledge strength and minimizing the uncertainty behind the assessments made. To know when the uncertainty is reduced sufficiently, the study shows that there is often a shared subjective assessment among those involved on whether more knowledge is needed. Only one of the operating companies had a tool that visualized uncertainty for activity along with the standard risk approach using probability and consequences in a matrix. Both companies acquired more knowledge about an activity to reduce uncertainty, which is the essence of reducing uncertain activities in the risk management process.

5.2. Consequences for risk management

The redefinition could significantly affect the tools and methods used in the risk management process. A shared understanding of risk contributes to effective risk communication for all involved parties. It is emphasized by the informants that discussing between decision-makers and knowledgeable personnel around risk assessment is essential for good and dynamic risk management.

Considering the uncertainty and an estimate of probability will be central during risk assessments. The assessed risk may be based on poor statistical experience data, and in this way, probability and uncertainty are linked. Findings from the study show that a visualization tool that one of the companies has implemented for assessing uncertainty contributes to regular meetings between decision-makers and subject experts, focusing on obtaining the necessary knowledge to reduce uncertainty. Reducing

uncertainty involves increasing the level of knowledge in decision-making.

The perception of risk indirectly influences risk assessment, as the experience of danger depends on knowledge about the assessed risk. When one has limited knowledge about risk, the perception of danger is often greater, leading to decreased confidence and conviction during decision-making. The implementation of an uncertainty dimension in risk assessment is crucial, along with the evaluation of probability.

The study indicates that the new concept of risk affects and changes risk communication, which has become more comprehensive and better for some. If risk communication related to risk management and assessment differs among actors in a dialogue about risk, it can create serious misunderstandings. This applies during awareness-raising concerning the knowledge one has about an assessed risk. The challenge is to find the balance when presenting risk information that neither over- nor underestimates the recipient's need for risk information. The challenge can be related to the Risk Management standard ISO 31000 regarding communication and consulting within the risk management process, which gives sufficient information to provide a more effective and accessible overview of risk (ISO, 2018).

6. Conclusion and further research

In conclusion, this paper has examined the possible impact of a new concept of risk introduced by the Petroleum Safety Authority Norway (PSA) in 2015 on the operational decision-making processes of the petroleum industry. The study found that although the level of familiarity with the new concept varied among informants, uncertainty was still assessed through direct and indirect evaluations. The implementation of the new concept has been gradual and is still under development. The traditional approach to risk evaluation based on probability and consequences is still being used. That does not mean that uncertainty is not addressed. Also, some decision-makers have incorporated the uncertainty dimension explicitly in the conventional risk approach.

The study highlights the importance of a shared understanding of risk and the need to handle uncertainty from various sources. Sources of uncertainty that emerged in the study include external factors, model uncertainty, consequence

and parameter uncertainty, inadequate expertise, and introduction of new technology. Knowledgeable personnel and subject matter experts and external suppliers contribute to increasing the knowledge strength and minimizing the uncertainty in the assessments made. The study also reveals that a visualization tool implemented by one of the companies for uncertainty assessment contributes to regular meetings between decision-makers and experts focused on gathering necessary knowledge to reduce uncertainty. The study emphasizes the importance of good risk communication for all involved parties and the need for discussions around risk assessment between decision-makers and knowledgeable personnel. The perception of risk indirectly influences risk assessment, and implementing an uncertainty dimension in risk assessment is crucial. The assessed risk may be based on weak decision-making grounds, such as insufficient statistical data, and in this way, probability and uncertainty are interconnected.

Risk management is essential in a constantly changing world, and the definition and understanding of risk will significantly affect the tools and methods used. The petroleum industry must continue to handle uncertainty, improve knowledge strength, and minimize the uncertainty behind assessments to ensure good and dynamic risk management.

6.1 Further research

In future research, it would be interesting to study which other methods and tools can deal with uncertainty. As the world is constantly changing, it will be essential to have good techniques and tools to handle the dimension of uncertainty.

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