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Visualizing risk related information for work orders through the planning process of maintenance activities

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A B S T R A C T

Major accidents are characterized by complex causal patterns with many factors influencing the occurrence of such accidents. Within the offshore petroleum industry the causes can be found not just in the execution of maintenance work, but also in the preparations and planning before performing the work. Planning of the work activities plays an important role in managing the activities and installation risk by identifying hazards and ensuring measures are planned for. One important basis for developing good plans and plan the work properly is to have the right information available at the right time in a format that facilitates understanding of important risk related aspects of the work. This paper presents a computerized display for a concept for how risk related information can be visualized in an operational context when establishing work orders. Design iterations have included participants from operating companies on the Norwegian continental shelf.

1. Introduction

Planning of maintenance activities serves several purposes, of which the most obvious ones are to provide a basis for efficient performance of the activities with the time and resources available. However, in hazardous industries, maintenance planning also serves to manage risk, by identifying hazards and ensuring that measures are planned for that can contribute to reduce risk to an acceptable level. In the oil and gas industry offshore, evidence shows that there is significant scope for improvement in this area. Sarshar et al. (2015) looked at 24 investigation reports of gas leaks on the Norwegian Continental Shelf (NCS) and the review showed that in 18 of the cases, factors related to planning were identified as contributors to the incidents. An example includes that unoriginal parts were used for a job on a hydrocarbon leakage which caused a leak incident.

There can be many reasons why the planning process is not sufficient, but an important basis for developing good plans and making good decisions is clearly to have the right information available at the right time in a format that facilitates understanding of important risk related aspects of the work. Fig. 1 gives an overview over the process. The starting point is that there are certain hazards, with associated probability and consequence that need to be managed. One identify relevant factors that influence risk and develop risk models to analyse risk. The output from this is a risk picture. In addition, Sarshar et al. (submitted for publication) also identified other relevant risk related information that is necessary to make good decision. This needs to be presented to the decision-makers (planners and others). Before a decision can be made, the information must be interpreted by the decision-makers and they have to make sense of it within the context of the work that is going to take place. The focus in this paper is on the presentation of the information to the decision-makers, or the visualization as it is described in the figure.

Relevant information has been identified by Sarshar et al. (submitted for publication) and the objective of this paper is primarily to investigate how we can present information about major accident risk in a manner that provides improved decision support in the planning process for activities on offshore oil and gas installations.

The scope of this paper is limited to the establishment of work orders and their assessment. These steps are followed by assessment and approval of a work order plan which is then sent offshore for performance. Earlier planning stages and execution of the work that has been planned is not studied as such, although an important outcome of a good plan is its safe execution.

The rest of the paper is structured as follows. Section 2 provides background and discusses work related to the scope of this paper. Section 3 and 4 describes the approach and process for the study. Section 5 provides the main results of the concept developed. Section 6 concludes the work and comments on future work.

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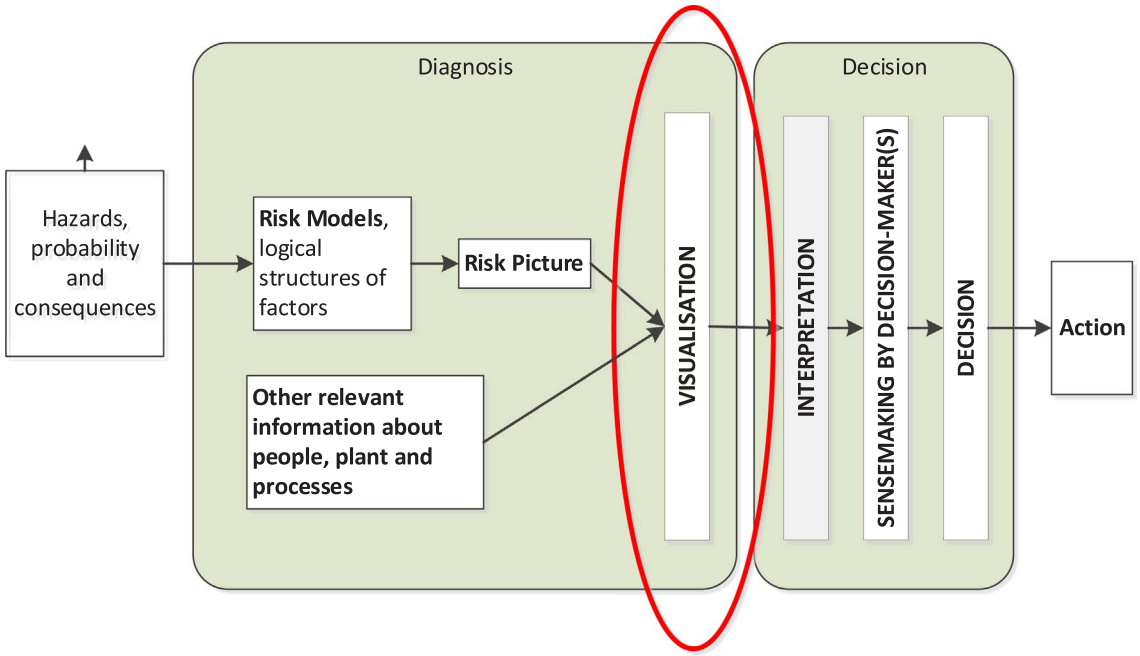

Fig. 1. Diagnosis-Decision-Action (simplified version of figure from Albrechtsen et al., 2013).

2. Background

Sarshar et al. (2015) identified several factors influencing major accident risk in the planning process that are related to information, e.g. «Information flow», «Communication" and "Misunderstandings". The challenges related to these were elaborated in a second paper (Sarshar et al., 2016). In a third paper (Sarshar et al., submitted for publication), the authors moved into the topic of information in more detail, and looked specifically at what types of information are required to ensure that the best possible basis is available for making good decisions in the planning phase - to develop plans in which the risk for major accidents has been explicitly addressed. In this paper, we follow a design process to present the information in a manner that provides maximum support to the planning process and the decisions made in the planning process.

2.1. The planning process

A typical planning process offshore has been described in earlier papers (Sarshar et al., 2015, 2016). To provide the operational context for work orders a short description of the planning processes is provided.

Planning of maintenance and offshore operations can be divided in several phases spanning from several years to a daily plan. The planning is normally done by the onshore organisation and communicated to the offshore organisation which is responsible for execution of the plans, along with handling unplanned activities. The time horizon of the different plans spans from years to days. The main plan spans for a year, the operational plan for up to three months, the work order plan for up to two weeks and work permits are applied for before the job is executed the following day. To provide some context to work orders, the following operational planning steps are described related to the scope of this paper:

- *Establishing work orders.* Work orders are essentially descriptions of work that needs to be done in a plant. This is typically prepared by those that have technical responsibility for the plant and includes description of the work, when it needs to be done and resources required. In some cases, this can be done a long time before the work actually is performed, depending on the urgency of the work. Addressing major accident risk at this early stage can help to identify and manage critical aspects at an early stage.
- *Establishing a work order plan.* This implies piecing together a plan for all activities that will be performed within (typically) a two-week period. This takes the individual work orders as a starting point, with key constraints being available resources. From a risk point of view, the key concern is now whether the total risk level in any given period is too high and whether there are interactions between work orders (activities) that can increase risk.
- *Approving work permits.* Some of the operations or sub-activities that a work order consists of require work permits that need to be applied for and approved. Approval of work permits is the final stage in the planning process before execution. An approved work permit is necessary before an activity can be executed and the focus at this stage will be similar to the two above stages combined: Accepting that individual activities are safe to perform and that the total activity level on a given day is acceptable.

In this paper, we are focusing on what may be called operational planning decisions (Yang and Haugen, 2015). Decisions can be divided into planning decisions and execution decisions, where the main distinction lies in the time available for systematic comparison and evaluation of alternatives. Execution decisions are typically made purely on basis of experience, intuition and context, without careful evaluation of alternatives. This may be compared to "Fast thinking" decisions as described by Kahneman (2011). Planning decisions may also be based on the same background, applying "Fast thinking", but at least time allows for more systematic analysis of alternatives.

2.2. Risk visualization as a tool

Based on our knowledge and experience through work with the petroleum industry operating at the NCS, most companies make use of separate tools and systems to manage different aspects of maintenance planning. Some operating companies have different software tools to manage the work activities in the different planning phases; different tools for managing barrier management, process and instrumentations diagrams, hazard analysis etc. These different systems often use tabular and textual formats to present information. Using these tools do not necessarily mean that all necessary information is made available and is