

RISK ANALYSIS PERSPECTIVES AS DEVELOPMENT APPROACH IN OFFSHORE OIL PRODUCTION

Dr.Ing. Bodil Alteren, Senior Research
Scientist / SINTEF, Norway

Cand.Polit. Bjørn-Emil Madsen, Research
Scientist / SINTEF, Norway

Dr.Ing. Jostein Sveen, Research Director /
SINTEF, Norway

M.Sc. John Monsen, Chief Engineer HSE /
Norsk Hydro, Norway

SUMMARY/ABSTRACT

Norwegian offshore petroleum production offers demanding organizational challenges. Due to the shift system, the employees have a discontinuous work situation; the shift system implies that many persons share each job, and that several changes with consequences for ones work may have occurred during the time off. There is a huge number of interfaces between divisions of labor, professions, companies, shifts, crews, managers-workers, personnel working land-offshore etc. The situation seems to invite for failures and losses in production efficiency as well as in health, safety and environment (HSE) matters.

During autumn 2003 the offshore oil production shift schedule at the Norwegian sector of the North Sea changed, till even more time off for everyone employed offshore. In January 2003, i.e. before the shift schedule change, one platform wanted to prepare to the new situation by starting the development process "Smarter Together". In cooperation with the research organization SINTEF, the process was implemented at Norsk Hydro's Oseberg Field Centre (OSF). Smarter Together is a four step organizational development process, based upon three core values: i) bottom-up participation, ii) focusing the actual work team, crosswise interfaces, iii) encouraging trust, playfulness and confidence.

The researcher team has the experience and view, that safety and efficiency are two faces of the same coin, rather than opposites. The goals for accomplishing the development process before the shift system change were improved work processes, giving increased safety, productivity and efficiency. The platform management aimed at introducing the new shift system at the platform without increasing the manning.

Systematically risk analysis approaches were applied in the process. The initial identification of improvement needs was fulfilled through several excursions, offshore and onshore. The results were reported in a risk assessment structure: 1) uncover potential incidents, hazards and unsatisfactory conditions, 2) identify direct and underlying causes, 3) analyze consequences, 4) judge probability and seriousness and 5) suggest measures. Search conferences were tailor-made according to what challenges to address and who to be participate.

Following the risk assessment structure described above, the groups worked with SINTEF prepared matrices. In addition, the group work had a coarse evaluation of the suggested measures, including cost / benefit assessments, identification of any new problems initialized by the measure, and suggestion of parameters for measurement of effects.

Maintenance was a target area to improve; e.g. planning and preparations, spare part systems and handling of them, as well as reporting and analyzes of repeated maintenance needs. The improvement potentials were to a large extent founded on the need for better cooperation and coordination between maintenance departments and production department, as well as better interaction between land-offshore, and between management and employees. SINTEF processed the output from the search conferences, suggested prioritizing criteria and prioritizing of the measures.

Norsk Hydro decided to implement the measures that the participants worked out during the search conferences. This paper describes the structure of the work, and illustrates the appearance and use of the risk assessment approach in prepared matrices. The paper also discusses how measurable HSE and efficiency results, as well as non-measurable effects, indicate a positive development at the OSF platform. The platform passed the "final exam"; they introduced the new shift arrangement without problems, with the same manning as they had.

1 INTRODUCTION

1.1 Challenges in the Norwegian Offshore Industry

The offshore oil and gas production industry is characterised by hazardous conditions and strong emphasis on safety, as well as extensive use of team working. The Norwegian offshore petroleum drilling and production has a complex work organisation, i.a., due to special shift arrangement. The employees at Norwegian offshore installations work 12 hour's per day for two weeks, followed by four weeks off duty. This shift system implies that several persons "share" the same job, including management positions. Different persons have different focuses and priorities, which influences how they perform. This also implies numerous interfaces between day and night shifts, crews, hierarchal levels, specialised professions, personnel working land-offshore etc.

The shift arrangement gives a discontinuous working situation; After four weeks off, work and working procedures may be rather absent from mind. Additionally, incidents and changes with consequences for ones work may have occurred during the time off. Figure 1 compares the work situation for an offshore worker to an onshore worker. The star symbols illustrate different tasks. The offshore worker line shows a two-weeks-on, four-weeks-off shift system. The figure shows differences according to the onshore and offshore worker's possibilities of repeating and learning tasks, as well as the onshore worker's possibility to learn more tasks. These other tasks may give supplementary experiences. Actually, we have experienced that a shift by chance had one year without carrying out an ordinary task, that management expected everybody to know well. This illustrates some of the challenges within the offshore industry [1, 2].

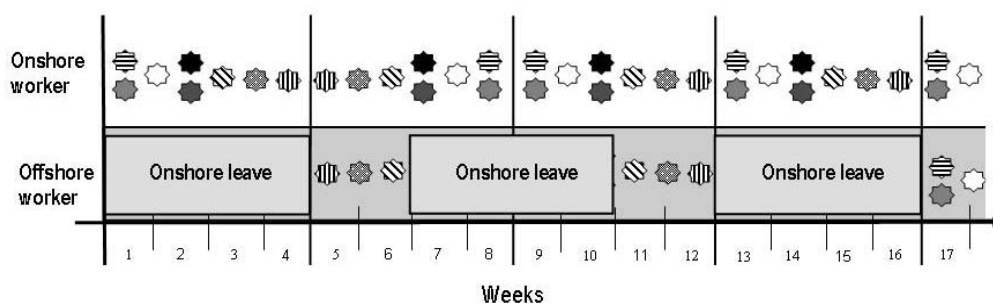


Figure 1. Symbols Express Different Exposure to Tasks; The Offshore Worker Gets Less Continuity, Fewer Repetitions and Less Diversity, Which Slows Learning

1.2 The Oseberg Field Centre Process Goals

Late 2002 Norsk Hydro and SINTEF planned a development process at Oseberg Field Centre (OSF). The management and the trade unions at OSF had agreed that they would carry out such a process, as part of the implementation plan for the new shift schedule. Several North Sea companies had altered their shift system already. They used to have a system, two weeks on-three weeks off, two weeks on-four weeks off. The new shift system would give four weeks off every free period. The process was initiated at OSF in January 2003. Offshore departments participating in the process were the production department, maintenance mechanical/logistics and maintenance electrical/automation. The different "stake holders" had somewhat different, but compatible, goals for the process:

- The workers: longer periods on onshore leave
- The management: new shift system with the same number of employees
- SINTEF: increased safety and efficiency at OSF by improving working processes and internal interaction across interfaces (departments, management-employees, offshore-onshore etc.).

1.3 The Paper Objectives

This paper discusses the way the Smarter Together project was carried out at Oseberg Field Centre, experiences during the project, and central features recognized during the work. The main purpose of the paper is to present how

risk analysis approaches were applied in a qualitative manner in order to prepare for the shift system change. The paper thus presents how the researchers:

- Worked with the operating personnel at Oseberg Field Centre
- Prepared search conferences with tailor-made program and group activities
- Used systematically risk analysis approaches as a tool for agreeing upon challenges and working out appropriate measures and solutions

We will illustrate the presentation with examples of the challenges addressed and their solutions. The paper will also discuss what measurable HSE and production efficiency results the process has produced. Chapter 3 “Accomplishment Experiences” is considered the main result-presenting chapter. It describes how the work was carried through and experiences on the way.

2 THEORY AND METHOD

2.1 *The Smarter Together Process*

Smarter Together as a four phased process (see Figure 2) was presented for the PSAM7 conference [3]. The action research framework, the researchers’ professional diversity and the three core values of the process were presented. The three core values are firstly a bottom-up participatory design, secondly the focus on the working team and the “community of practise” and thirdly the explicit efforts to encourage trust, playfulness and confidence. The process represents a structured task analysis, where the aim is to develop and implement measures in order to improve the organization’s fulfillment of its tasks. The researchers involved have operationally trade knowledge and are solution oriented. We combine the human, technological and organization perspectives.

One of the main hypotheses of “Smarter Together” is that safety and efficiency are positively correlated to each other. Both these entities are indications of work quality. Subsequently, safety and efficiency are both dependent of the amount and the quality of individual and organizational knowledge, communication and learning. This means that the level of safety (as well as efficiency) is related to collective behavioral patterns and performance, i.e., how people are working together. This hypothesis is explained earlier [4, 5].

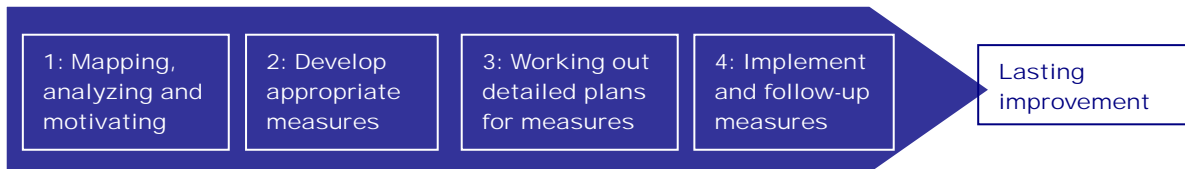


Figure 2. The Smarter Together Process in general

2.1.1 *Mapping, Analyzing and Motivating*

A structured mapping of the organization is prepared i.a., on the basis of the SMORT method [6, 7], combined with oil industry process knowledge. In this phase we emphasize to meet as many members of the organization as possible, preferably everybody affected, onshore and offshore. This is done through group meetings, plenary sessions and personal interviews. SINTEF carries out well prepared interviews with a representative number of persons with different positions. Our questions invite the interviewees to present improvement potentials at their workplace. Through this SINTEF identifies operational and organisational competencies and challenges, and we determine what areas to focus in the coming improvement process. This phase also has an important motivating purpose.

2.1.2 *Designing Search Conferences*

A major feature of the action research project Smarter Together is a series of search conferences for development of appropriate measures [3], see phase 2 in Figure 2. SINTEF prefer these held onboard the Coastal Express. The Coastal Express trips represent positive experiences since they give “exotic” experiences that have intrinsic values for the participants. Another value is that everyone must be onboard, present. No one can leave for evenings at home. This helps everyone’s minds to be concentrated towards the common efforts.

The program is built up by a mix of introductions, open discussions, structured group work and professional theory/research based presentations. The professional presentations are directed towards the challenges addressed.

We however limit the time on introductions and presentations. It is most important to spend time on the topics the participants themselves are involved in.

The participants at the conferences are a representative mix of the personnel affected. Thus, the staff varies in accordance with the operational challenges in focus. All search conferences are tailor made; SINTEF defines what subjects to address, and what central participants are needed. The participants represent the “communities of practice” for the chosen topics. It is important to choose the subjects and participants carefully, so that the participants draw the lines into the organization afterwards. The participants must be engaged and have ownership both to the problems and their solutions. They are the ones to carry out the measures afterwards, and they should be good ambassadors for the measures chosen.

Much effort is carried out to adapt the group tasks to the real working day and known challenges. The group work is based on the previously analyzed results. As a warming up, a first group work is carried out in department homogeneous groups, discussing strengths and challenges in their own department. The second group work is what really yields the plans for the future. The second group work is carried out in mixed groups, with group members from the affected departments, hierarchical levels, land-offshore etc.

This group work is prepared by SINTEF in a risk analysis design. The risk analysis approach prepares for effective solution of the tasks, with minds and measures directed towards fundamental causes. Addressing the fundamental causes is supposed to give long term effective measures.

2.1.3 Reporting

SINTEF reports the results of each search conference separately. We then give every problem and measure a unique number as a reference for future work. Thereafter SINTEF processes and structures all measures from all search conferences in common. Measures related to each other are then merged and rewritten to a unified comprehensive measure. SINTEF also suggests criteria for prioritizing measurements, and suggests a prioritized ranging.

SINTEF concludes this part of the work by reporting all the work on a final CD. The CD report includes notes and reports delivered, videos taped during the work, and recorded introductions and conclusions made by OSF management and SINTEF project management.

2.2 Risk Analysis as Basis

The term risk analysis covers several methods for assessing risks. These include quantitative and qualitative methods [8, 9]. Risk analysis judge the risk connected to potential incidents, following a certain pattern:

- Uncover potential incidents and hazards
- Identify possible causes (direct and underlying)
- Analyze consequences
- Decide the risk (probability and degree of seriousness)
- Suggest and evaluate measures

The approach is suited for development processes in any industrial setting, also as a mean for organizational development. When measures have been worked out, they are evaluated. The evaluation is another step by step process, still based on a structured risk assessment mindset. An initial evaluation is done to prioritize among the measures. Later, the effects of the remedies must be measured. The process continuation is:

- Accomplish cost / benefit assessments, i.e., judging the utility value against the costs
- Identify whether any new problems may arise from the measure
- Choose measures
- Choose parameters for measurement of effects
- Decide who are responsible for accomplishing the measure
- Decide the accomplishment process and when to fulfil the measure

3 ACCOMPLISHMENT EXPERIENCES

3.1 Mapping

SINTEF had three excursions to OSF, with two weeks between each tour, in order to meet all the offshore shifts/employees. Each trip lasted for three days. SINTEF also had meetings with the OSF onshore organization. Arriving offshore, first of all we had a common meeting with those present from the OSF 2-4 shift steering

committee, the head safety deputy and the managers present. After that, SINTEF introduced the process to the affected departments in six plenary meetings, i.e., each department and shift separately. This arena was also utilized for carrying out introductory plenary interviews. Thereafter SINTEF fulfilled personal interviews. We also followed, observed and discussed with employees in their normal working day.

Before SINTEF left the platform, we had a concluding debrief with the steering committee, safety representative and managers. We then presented our results and interpretations. This informed them of what findings we planned to use, and it gave them an opportunity to comment our impression. This was done each time we left the platform.

The SINTEF team on the three offshore trips varied. We provided for continuances, but we also used different persons / competencies, in order to cover more areas and reveal more challenges. We were always four persons offshore at a time. Offshore we fulfilled the plenum meetings in common. For the personal interviews we were split, two by two.

The unions' representatives of the steering committee were the ones that initially presided the plenary sessions during our introductory offshore mapping. Employees at the platform had experienced that previous projects had failed or had not been consistently implemented. The unions' significant role in the project convinced the employees that the efforts would not be in vain.

The analysis gave us this list of main areas to address in the improvement process:

Maintenance and logistics

- Establish a good maintenance strategy
- Improve the maintenance planning and preparations
- Improve the spare parts system and the functioning of the system
- Simplify the working permissions system for some specific types of cases
- Improve the reporting and analysis of maintenance data

Computer systems

- Training and provide more available user help for the computer systems
- Simplify the system of passwords and user identifications

HSE control

- Priority of safety versus regularity / economy
- Formal procedures versus working practice

Humans and organization

- Improve the psychosocial working environment and culture
- Develop and utilize knowledge and competence better
- Clarify roles, responsibilities and management
- Coordination between shifts and crews

The report presenting the identified improvement needs, was structured in the themes presented above, addressing the challenges experienced. Each theme was built up on the basis of risk analysis perspectives, i.e., every problem area (e.g. "Maintenance planning") was divided in the sub headings: Employees views about the problem, the problem's causes, consequences and risk of the problem and employee's suggestions to solutions.

3.2 Search Conferences

The typical composition of the search conferences' program was presented in Chapter 2. The challenges reported from the mapping and analysis were carefully adapted for four search conferences. They had the themes:

1. Unnecessary close-downs and time loss
2. Planning and preparation of maintenance
3. Collecting and use of maintenance data for planning, reporting and analysing
4. Management, responsibility and decision-making

Each conference spanned over two full working days, i.e., three overnight lodgings. Three search conferences were completed on the Coastal Express, one at a hotel. When docking the last morning, the conferences were concluded by two well known Norwegian jazz musicians, who demonstrated the subject "improvisation" from the perspectives of professional musicians. These musicians are also academics, one is professor at the university, thus they discussed the subject in both theoretically and operational terms [10].

3.2.1 Management Participation

The participants at the search conferences were a mix of offshore personnel from the three relevant departments (the production department, maintenance mechanical/logistics and maintenance electric/automation), as well as higher level management offshore and onshore. The search conferences usually had among 25 participants, divided in three or four groups during group work.

One could fear that the management presence could inhibit the discussion of critical human factors problems [11]. This did not happen. The crew wanted their managers to be present so that they could discuss key issues openly with them. How important it was for them, became evident when a group presented their work, while the top level manager was outdoors answering an important telephone. The group was disappointed because the manager did not hear their presentation, and this was theme for a confrontation afterwards.

The managers' participation is overall important due to the managers' and employees' need for a common understanding and ownership to the problems and solutions. The decision making power must be present, so that the groups know that their proposals will be honestly considered and some of them will be carried into effect. The personnel mix is thus important, since it helps them to apply the information and the measures in practice at the workplace.

3.2.2 Group Work

The most central element of the search conferences is the group work. SINTEF pre-processed the challenges from the analysis into matrices, following the systematically risk analysis approaches.

In advance of the four conferences, SINTEF sorted and adapted the challenges to address appropriate themes. SINTEF also decided who to include from the company. We designed a special matrix for the group work in order to direct the solutions towards underlying causes. The groups received their matrix, showing what problem areas that they ought to work with. SINTEF used the information from the mapping report as a basis for filling in suggestions to causes and consequences into the columns before the conferences. The causes and consequences pre-defined were drafts only, and the groups were invited to alter the content. Table 1 demonstrates how the matrix was pre-prepared before the conferences. This was an effective approach, lining up the track for the group members' minds. It was time-saving, exploiting information already gained.

The group participants prioritized what challenges they found most important to work with, and worked concentrated with filling in the columns of the matrix. SINTEF did not fill in any of the pre-defined improvement suggestions. Measures were entirely worked out during the conferences. In the cell for improvement suggestions, the group also worked out whether the measure could produce any new problems, a cost/benefit analysis and suggestions to measurement parameters. SINTEF functioned as group leaders and secretaries during the work.

Table 1. The Pre-prepared Group Work Matrix

Problem / description	Causes	Consequences	Improvement suggestions *
Insufficient ability to fulfil projects at the platform	<ul style="list-style-type: none"> • The organization (land/offshore) initiates too many new projects, before concluding those going on • Insufficient coordination between new and existing projects • Little cooperation across crews on projects • Insufficient respect for and follow-up of other shifts decisions – the next crew might alter the plans. • Indistinct who is responsible for following up 	<ul style="list-style-type: none"> • Little continuity in started projects • Changing focus often • Looses the improvement potentials one could have • Looses loyalty • De-motivated employees 	

* This column was not filled in, in advance. For the other columns, the suggestions were often altered during the work.

All search conferences were rounded off with a plenary session, where the groups presented their work for the other participants at the conference. Finally, the participants prioritized what were the “top ten” measures and defined who was responsible for carrying out the measure. The responsible persons were chosen among those present, usually they suggested themselves. This last session was initiated by the participants themselves. It

functioned well. The responsible persons were eager to start the work. They often contacted the researchers the day after concluding the conference, in order to have the file describing the concrete distribution of tasks.

3.3 The Next Steps of the Process

SINTEF structured the measures from the conferences, grouped them, and rewrote those related to each other to unified comprehensive measures. References were given to the original measures incorporated. This reduced the amount of measures from 120 singles to 40 comprehensive measures.

The 40 restructured measures were divided in nine groups of subjects:

- *TAG*: e.g., “update spare part lists with drawings and data sheets, attached to the correct TAG label”
- *Store and logistics*: e.g., “use exact and correct characteristics when ordering spare parts”
- *Synergi* (incident reporting system): e.g., “right classification of the seriousness of incidents”
- *Maintenance analysis*: e.g., “record and analyse repeated maintenance jobs that gives production loss”
- *Planning and accomplishing maintenance*: e.g., “report back immediately when the job is finished”
- *Management* :e.g., “engage operational managers also on night shifts”
- *Training*: e.g., “guided use and training within SAP (the maintenance IT system)”
- *Organisation*: e.g., “common shift change days for production and maintenance departments”
- *IT* (information technology): e.g., “direct contact between offshore employees and helpdesk”

When rewriting the measures, SINTEF also processed them. The results were presented in tables, see Table 2. SINTEF evaluated the rewritten measures based on a coarse cost / benefit analysis. The assessment included suggestions for prioritizing criteria, as well as suggestions about what measures to prioritize. What criteria SINTEF used in the qualitative cost / benefit judgement of the measures is shown in Table 2.

Table 2 The Comprehensive Presentation of a Measure

No. 14: Introduce common crew change day for production and maintenance departments			
Description of the measure:			
The crew changes at the three departments (maintenance electro / automation, maintenance mechanics / logistics and production) are presently distributed over three days. This causes reduced working efficiency at the platform for three days. This should be changed, so that all three departments have crew changes during the very same day.			
References:			
Search conference 1	Search conference 2	Search conference 3	Search conference 4
<input type="checkbox"/> Measure 1.1.8	<input type="checkbox"/> Measure 2.2.5	<input type="checkbox"/> Measure 3.1.10	<input type="checkbox"/> No measure
Measure 1.3.4	<input type="checkbox"/> Measure 2.2.7		
Effect of the measure:			
The measure will give better exploitation of personnel and therefore better turnover of maintenance tasks. The measure may also give increased safety, since the production department then don't have crew changes during maintenance jobs or maintenance peaks. The measure might cause logistical challenges, according to availability of helicopter seats and making of beds. The measure will probably not affect the crew change costs. Conclusion: The measure removes a cause to limited maintenance capacity, and a cause to decreased safety. It does not have any negative consequences.			
What costs are connected to the measure?		What benefits will the measure give?	
One occcation cost:	No	Saved working time:	Yes
Running costs:	No	Increased safety:	Yes
		Increased motivation:	Yes
		Increased competence:	No
		Reduced loss:	Yes
		Reduced costs:	No
Overall evaluation: Does the benefits exceed the costs?			Yes

Based on the total evaluation, SINTEF suggested what measures to introduce immediately and what to fulfil later. Norsk Hydro followed these recommendations. The OSF steering committee detailed the plans, decided who to be responsible, when to do the work etc. The implementation process began shortly after the conclusions from the conferences. Norsk Hydro established a long-term committee, “manning forum”, to follow up the process. They have demonstrated endurance in this project.

4 EFFECTS AND DISCUSSION

Norsk Hydro decided to fulfil all 40 measures. Members of the organization had suggested a few of these measures even before the Smarter Together process started. These earlier proposals had then been refused due to costs or work load. The managers did then probably not realize the importance and the potential of the proposals. During Smarter Together the management agreed upon these proposals. An example of this is the measure “update the spare part lists, drawings and data sheets, and attach them to the correct TAG label”. The personnel had struggled with mixed-up and imperfect systems, while the managers earlier had judged the costs of correcting it higher than the benefits. After the Smarter Together work, this was a prioritized task.

Smarter Together proved to attain a special position at OSF. An example is a platform manager that insisted on getting another project placed within the Smarter Together portfolio in order to secure status, accomplishment and follow-up resources for his project. The unique cooperation between management, unions and researchers was probably one of the explanations for the solid standing of the project. Other explanations are probably that the company and personnel invested a certain amount of time and money in the process, and that everybody at the platform departments was included and heard (about 250 persons). Also, from the beginning, SINTEF stated and required that measures should be realised. These are Smarter Together features that distinguish this project from some of the previous projects at OSF.

The process started in January 2003. The manning forum at OSF worked out a status report for the Smarter Together process in September 2004. The forum went through the state of the art of measures, and presented trends by central Key Performance Indicators (KPI). The KPIs indicated a positive development at OSF:

- Sickness absence were halved during one year (accumulated 50 days of absence, week 30, 2003; acc. 25 days of absence, week 30, 2004)
- The number of falling outs for “liquid process trains” were halved over two years (34 falling outs per Sept. 1., 2002; 17 falling outs per Sept. 1., 2004)
- Hydro carbone gas leaks were halved over two years (99 occations in 2001; 42 occations in 2003)
- Mechanical maintenance lag (“backlog”) reduced with one third (ca. 6000 hours in week 25, 2003; ca. 4000 hours in week 25, 2004)
- Serious incidents unchanged (Have they attained a higher degree of reporting, as was the intention of one measure?)

Finally, “the ultimate test”:

- OSF has introduced the new shift arrangement as planned without any problems, i.e., two-weeks-on – four-weeks-off, with the same manning that they had!

These results seem positive for OSF and the Smarter Together process. However, Smarter Together was not the only activity going on in this period. Other activities were in progress simultaneously. We however have some indications that Smarter Together had a positive influence, e.g., that unions’ representatives and managers have kept in touch of their own accord afterwards. This fact suggests “face value”, and that the participants are generally positive about the development process. SINTEF has worked on other projects for these contact persons afterwards. The results of the process at least indicates a positive psycho-social value of offering an arena where people can get to know each other better, both as individuals, as members of a team at work, and as holders of diverse, but complementary knowledge and experiences, across hierarchies and departments. SINTEF accomplished a similar action research process at another platform, Snorre A, prior to the OSF-project. This other platform reported better drilling rates ($p=8\%$), and a parallel drop in the injury rates ($p=7\%$) [3]. Thus, the results from OSF and Snorre A support the hypothesis of Smarter Together: that enhanced learning and knowledge utilization, positively affect both safety and efficiency.

5 CONCLUSIONS

The Smarter Together process at Oseberg Field Centre has been well received among the participants, it has proved its status at the platform, and the KPIs suggest a positive development. Other initiatives have been run before, during and after the Smarter Together. What is the result of Smarter Together and what is the result of other activities, can not be separated. When the laboratory is a platform, this is one of the disadvantages.

Regarding the ambiguity in the results presented above, drawing an absolute conclusion is not apt. However, producing organizational change is extremely difficult, and it is a fact that a large proportion of such projects fail, some even make more damage than good. This has not happened in this case, quite the contrary, even if this is difficult to prove scientifically. Be this, the risk assessment approach, carried out within the Smarter Together

framework, has proven strength, and does not fall short compared to the effects of other methods for enhancement of safety and efficiency in the oil industry.

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