SPE 99847

Facilitating Risk Management in E&P Using Collaboration and Data-Visualisation Tools

G. Cain and E. Deliac, Petris Technology SAS

This paper was prepared for presentation at the 2006 SPE Intelligent Energy Conference and Exhibition held in Amsterdam, The Netherlands, 11–13 April 2006.

Abstract

Technological progress alone is insufficient in the E&P industry today given the wider administrative, legal and organisational challenges that E&P development Projects currently have to contend with. In particular, risk management has become fundamental to both operator and service provider companies.

This paper presents two E&P case studies that illustrate how the use of collaboration and data visualisation tools provided significant assistance and support to E&P risk management activities. The first case study concerns a deep offshore E&P development project where the risk management activity had become virtually impossible to coordinate because of a very aggressive project execution environment. The implementation of collaboration technology for the project's executive management team established and sustained risk visibility at the appropriate level, whilst allowing all risk-related information to be seamlessly integrated with the rest of the project execution plan. The second case study concerns the collection and monitoring of safety and risk performance indicators (RPIs) at operational E&P sites of a major oil company. We will describe how analysis and feasibility work led to the design and development of a methodological tool capable of collecting and organising a diversified set of RPIs and then presenting them in an innovative graphical form for analysis and prioritisation.

The added value for E&P projects is evident: risk management without risk.

Introduction

Exploration and Production innovation today is largely focused on technical challenges in areas such as enhancing subsurface imaging to improve exploration success and increasing recovery from existing and new fields using smarter operating systems. Such technological advancements and achievements alone, however, have become insufficient to ensure successful E&P operations given the widening administrative, legal and organisational challenges that field development and other projects currently have to contend with.

In particular, risk management has become fundamental to the systematic mitigation of the increased operational and managerial liabilities to which both operator and service provider companies are now exposed. As such, risk management plans are now fully integrated into the overall E&P management systems and processes.

However, all E&P operations are subject to the usual battery of day-to-day management problems, and all parties quickly become absorbed in a complex environment where the prioritisation of actions primarily depends upon the individual. This, compounded by the geographic dispersion of key personnel, site personnel rotation, and poor information circulation, can eventually lead to risk management activity losing "visibility". In the worst of cases, risk management activity may virtually cease altogether.

Two recent types of technology bring innovative solutions to this problematic situation. The first type facilitates collaborative project management for virtual teams, allowing risk to be integrated as a key component during project execution, and thus be a source of action items, deliverables, milestones, time assignments and reporting, just like other project components. The second type uses hierarchical data representations to graphically represent heterogeneous risk-related information by highlighting importance criteria together with performance or deviation with respect to a target. Figure 1 illustrates how these technologies enable the implementation of a global risk management approach based upon a "risk portfolio" comprised of a "risk register" to drive mitigation actions, and a "risk indicator data base" for visualisation and analysis of performance. Using this approach, risk can be dynamically associated with the management of field development or operations, from a planning and execution perspective as well as from a performance and diagnosis standpoint.

This paper presents two E&P case studies that illustrate how the use of collaboration and data visualisation tools provided significant assistance and support to E&P risk management activities:

- Use of collaborative project execution management technology (PEMT) on a deep offshore E&P development project with a significant risk management component and severe difficulties with coordination;
- Collection and monitoring of safety and risk performance indicators (RPIs) at operational E&P sites of a major oil company, using graphical representations to expose and prioritise critical risk factors associated with site production.

<u>Case Study 1</u> – Deep Offshore E&P Development Project

The first case study concerns a deep offshore E&P field development project that is particularly complex and challenging, involving significant financial investment, multiple work packages, complex interface management, an aggressive execution schedule (from basic engineering though to commissioning), and major technical challenges for each work package. In addition, it has demanding partnership agreements and complex concessionary conditions.

Although the risk management plan was an extremely important component of the overall project management system, the risk management activity had become virtually impossible to coordinate and was rapidly losing momentum. The introduction of collaboration technology for the project's executive management team not only provided immediate "mobilisation" for the risk management process, but also established and sustained risk visibility at the appropriate level.

Background

Once the project received sanction, significant time and effort was invested in rolling out the risk management programme. Responsibility for risk management was rapidly assigned, and the risk identification process was set in motion though brainstorming sessions, interviews, and peer reviews in order to thoroughly and systematically identify and register all project risks. Thereafter, risk assessment was followed by risk reduction planning, and the entire risk register together with all planned mitigation activity was entered into a single database that the risk manager planned to use as the core risk management support tool for the entire life cycle of the project.

Whereas in theory the risk management component of the project management system was now "up and running", in practice, risk management activity (as well as other "horizontal" components such as interface management coordination and action item follow-up from executive management meetings) quickly began to lose visibility and ineffectiveness as project execution "picked up speed".

The project objectives were clear, the organisation was well established, and the management procedures were in place. Further, the executive management team was fully aware that a collaborative effort was critical to achieving their common project objectives. However, the risk management cycle quickly became more and more difficult to assure. It was, quite simply, impossible for the risk manager to obtain sufficient timely information from project team members to keep the risk register and mitigation action plan up to date. Further, the need to circulate (and retrieve) individual "risk sheets" (produced from the single offline database) to work package and other managers was a huge impediment to keeping information current. With over 300 registered risks, only the "top ten" were really receiving pro-active follow-up, and the risk management programme was slowly becoming inert.

The underlying problem was the inability to effectively collaborate in real time. A further problem was the lack of credible technology support for such collaboration.

Collaboration Tools to Facilitate Risk Management

The Project Execution Management Tool referred to in this paper as PEMT [1], has been successfully deployed in a number of different E&P settings, including the project which is the subject of this case study.

The PEMT is a web-based project execution management tool that provides project team members with a robust, project-oriented collaborative environment that naturally facilitates the task of capturing, synthesising, analysing, sharing and prioritising project execution data and information. The PEMT's data repository is "action item" focused, and is organised around objects such as Projects, Teams, Milestones, Tasks, Risks, Issues, Meetings, Next Steps, Documents, and Deliverables etc. As such, the PEMT is completely generic and can be quickly adapted to any project execution scenario.

The decision to adopt the PEMT as the collaboration support tool for this deep offshore field development project involved "roll-out" for three major themes (Risk Management, Meeting Management and Interface Change Request Management). The focus of this example is limited to illustrating how the PEMT provides "life-cycle" support for the project risk management programme (within the wider context of coordinated action planning management for all themes).

Deployment of the Collaboration Tool

The key to a successful deployment of the PEMT lies in the careful definition of the "usage methodology" employed by the project team. "Usage methodologies" are the behavioural guidelines that ensure that the people (project team), the processes (Project management system) and the technology (PEMT) are fully synchronised.

The first step in the deployment process, then, was the migration of the existing risk register from the offline data base into the PEMT. Once this was achieved, the definition of the "usage methodology" for project risk management was a simple task of mapping the "trigger" and other events in the risk management process onto "defined interactions" ("usage methodologies") with the PEMT. With the one time migration complete, the vehicle for effective collaboration was in place.

PEMT–Based Collaboration for Project Risk Management

As new risks are identified by the project team they are progressively catalogued in the project risk register. Entering new risks is a straightforward process, since the corresponding PEMT data entry screens are parameterised in advance so that the classification process (area, category, status, and type, etc.) is consistent with the risk management plan. Once registered, each risk is assessed, reclassified if necessary, and eventually subjected to risk reduction planning. As a result of this process, an "identity card" for each risk is progressively (and collaboratively) established (see Figure 2 – Risk identity card).

As the Project progresses, these risk "identity cards" will be updated as necessary. For example, completed mitigation actions will eventually give rise to reassessment of risks, changes in priority or visibility, or even closure. All changes to risks are tracked, and in particular a full history of assessment revisions is maintained. The assessment sheet itself is also completely customisable within the PEMT, again allowing complete consistency with the risk management plan (see Figure 3 – Assessment sheet)

An interactive view of the risk register (see Figure 4 – Risk register) shows that visual visibility (colour attribute) and priority have been allocated based upon a risk's score (as defined in the risk management plan). Immediate action planning priority is given to medium and high scoring risks and so mitigation actions for low priority risks are assigned a "pending" status to ensure that individual work lists do not become cluttered with actions that are not considered "mission critical" at a particular point in time.

The risk management plan for this offshore development project also required a regular review of the "top ten" risks, such risks being considered as critical and of high priority. The "top ten risk" list is reviewed and updated as necessary during each weekly project progress review meeting. To assist this review process, the PEMT's capacity for customised reporting was used to construct a report in the format required by the project risk manager. This custom reporting capacity was also employed to facilitate the bimonthly risk reporting cycle; the tables for the risk report being directly produced from the PEMT.

Added Value from the PEMT

As a project progresses, the risk register becomes a natural "knowledge base" for risk mitigation activity that can be readily reused. Not only does it capture risk identification and assessment information, but it also provides a history of monitoring, reassessment and mitigation activity. Risks that "hit" are easily identifiable together with the "aftershock" analysis.

Case Study 2 – Operational Risk Dashboard for E&P Sites

The second case study concerns the collection and monitoring of safety and risk performance indicators (RPIs) at operational E&P sites of a major oil company. We will describe how analysis and feasibility work led to the conception and development of a methodological tool capable of collecting and organising a diversified set of RPIs and then presenting them in an innovative graphical form for analysis and interpretation.

Operational Risk Management

Operational E&P sites and facilities are sources for a diversity of operational data collections. While some of these data collections are well structured and relatively easy to manage and display graphically (e.g. field production information and field operating expenses), other data collections are much less structured and much more difficult to represent.

Safety and risk performance indicators (RPIs) provide a good example of such unstructured data collections, since they are inherently difficult to visualise homogeneously. Diversity of origin, difficulty with the definition of limit values, problems concerning aggregation, and conceptual difficulties concerning interpretation are all factors which compound the problem of homogeneous graphical representation.

Irrespective of this problem, there is an undeniable operational requirement to compile, visualise and interpret RPIs so that site operations staff can, for example:

- Identify issues that require immediate attention, further analysis or clarification; and
- Be proactive in defining "target" profiles that can be used to set objectives for operational sites.

Constructing an adapted risk register with simple attribute values for each risk factor is not, however, straightforward. The diversity of the risk factors requires that they be classified and hierarchised to facilitate interpretation and aggregation. In our particular example, it was also necessary to provide field operations personnel with a simple and user-friendly data editing tool for data collection and modification.

Visualisation Tools to Facilitate Interpretation of RPIs

The technology solution described in this paper (hereinafter referred to non-commercially as RPI Tool or RPIT [2]) provides a simple and effective environment within which to compile, visualise and interpret safety and risk performance indicators. The scope of the RPIT is not, however, limited to safety and risk performance indicators. It can, in fact, be deployed in any business situation where performance metrics and key performance indicators (KPIs) of disparate origin and structure need to be brought together for display and interpretation.

The RPIT's graphical displays are actually "Tree Maps" [3, 4 and 5]. A "Tree Map" is a two-dimensional "space-constrained" representation of a hierarchical data set that is constructed by dividing the display into a nested sequence of rectangles whose areas (sizes) correspond to an attribute of the data set. Using size, colour and arrangement, Tree Maps can represent large volumes of data in a synthesised manner on a single display. Typically, "size" is used to represent "importance" and "colour" is used to represent "performance". Tree Maps leverage the human brain's natural ability for visual perception.

The example "traditional" Tree Map shown in Figure 5 shows 26 producing fields grouped hierarchically by country and then by region. Each rectangle in the map corresponds to a single field, the size representing its production target and the colour representing its actual production as a percentage deviation from this target. One's eye is naturally attracted by Field 24 whose production target is relatively important, but whose performance is 18% below target.

Extensions to the Tree Map Concept

In general, when working with performance indicators (RPIs or KPIs), the general principal that the areas of the nested rectangles within a Tree Map can be progressively aggregated (since their attributes have the same units) no longer applies.

A particular feature of performance indicator hierarchies (in particular RPIs) is that each individual RPI may have its own particular value range against which its individual performance (good or bad) will be measured. However, from the perspective of map interpretation, indicators displayed together must have their performance measures "synchronised" in order for the visual appreciation of "good" or "bad" performance to be the same for all indicators.

A set of RPIs for an operational site, for example, may include indicators for "the ratio of failed tests to the total number of tests conducted" and "the number of irregularities recorded for locked valves". Not only are the scales of these two indicators different, but one also needs to know how to interpret each indicator with respect to its own particular scale. As such, it is necessary to know the points on each scale (limit points) at which the performance passes from good, to OK and then to bad.

The RPIT caters for this requirement by computing a set of "normalised" attribute values for each RPI using the "actual" attribute values together with associated "limit points". The resultant map of "normalised" attributes then allows individual RPI performance to be homogeneously interpreted from a visual perspective (see Figure 6).

Operational Risk Management for an E&P site

This simplified example provides an illustration of the graphical representation and analysis of safety and risk performance indicators (RPIs) for a particular operational site. Figure 7 shows the chosen method of classification for the indicators, each indicator being placed in both a Domain and a Class. Certain indicators are further identified as representing a Major Risk.

In this particular example, the Class may be either Documentation or Practice. Indicators in the Documentation Class collectively provide a measure of the "state of currency" of critical site documentation. Similarly, indicators in the Practice Class provide a measure of the operational "state of health" of the site. For example, the indicators "inspection backlog on vital equipment – cumulative months" and "inspection backlog on vital equipment – items concerned" are both specified with scales that increase from zero. In each case, limit values will be associated with the indicators to facilitate analysis.

The classification by Domain allows the RPIs to be studied from the perspective of a particular "domain of interest". Examples of RPIs from each Domain include:

- "Number of audits with unacceptable results" (Conformity);
- "Number of faults which occurred during operations" (Conformity);
- "Number of priority purchasing cases" (Operations);
- "Site meeting backlog" (Operations);
- "Number of safety feedback notices issued" (Feedback);
- "Total recordable injuries rate" (Feedback).

Figures 8, 9 and 10 provide example views of the compiled safety and risk performance information for this simplified case. Figure 8 shows all RPIs classified first by Domain then by Class. No distinction is made between the RPIs in terms of importance (size), but the performance criterion (colour) has been normalised using the individual "limit points" for each RPI. Upon analysis, it is noted that several RPIs are showing poor (orange) and very poor (red) performance.

Figure 9 shows the same set of RPIs, but this time classified by Class then by Domain. In addition, the RPIs representing a Major Risk have been doubled in importance (size). The performance criterion (colour) is unchanged. In this view, it is noted that the RPIs that were previously noted as having very poor (red) performance lie exclusively in the Documentation Class. However, the RPIs that were previously noted as having poor (orange) performance are all related to the operational "state of health" of the site (Practice) and all represent Major Risks. Figure 10 provides a "zoomed and filtered" view of the Practice Class showing only the RPIs representing a Major Risk.

Even in this simple case, the potential for alternative (static or responsibility-based) analysis and interpretation scenarios is clear. However, when working with "real world" cases, there are a number of other issues that should be kept in mind, certain of which relate to the way that RPIs are specified. For example:

- Certain RPIs may have reverse scales with respect to their measure of performance.
- Limit values can evolve and be tuned over time as familiarity with a set of RPIs increases.
- In our simplified example, poor performance in the Feedback Domain could be an indication that the site is not obtaining good benefit from Incident Analysis. However, it could also mean there were no incidents reported. It is important, therefore, to specify RPIs so that their interpretation (within context) is unambiguous.
- The method of classification may vary and evolve, but it should be kept homogeneous for all sites if the intention is to perform multi-site comparisons.
- When working with RPIs, the importance criterion (size) is not always straightforward to define. Using the size criterion to help identify "Major Risks" is one example of how to define importance.
- Any number of Performance criteria can be defined for the RPIs. As such, it is often useful to include additional performance attributes, such as a comparison with values from the previous month, with the same month from last year, and with a "rolling 12 monthly average".

Conclusions

The PEMT's natural ability to provide a project-oriented and structured collaboration environment within which to execute the project risk management plan is a fundamental prerequisite for its successful deployment. With the Project organisation (people), risk management plan (process) and PEMT collaboration tool (technology) in place, the "enabler" for successful collaboration lies in the careful definition and deployment of "usage methodologies" that will assure "homogeneous collaborative behaviour". Once deployed, the PEMT is capable of supporting the risk management programme during the entire life cycle of the Project, which, in particular, means that the risk register will be continuously synchronised with the project since risks will be regularly reassessed. The added-value for the Project is therefore significant, since the possibility of the risk management programme itself losing impetus or visibility is eradicated.

Safety and risk performance indicators (RPIs) are typically unstructured and difficult to analyse and interpret collectively. The ability of the RPIT to provide a natural and intuitive method of classification and analysis for such RPIs is a major step forward in globally tracking and measuring safety and risk performance information (as opposed to just working with small sub-sets of such RPIs). In particular, the ability to perform instantaneous analysis, as well as to observe both long and short-terms variations, means that clear objectives can be set and monitored within the actual operating context of a site. Periods or situations that engender increased exposure to risk can thus be anticipated, and operational adjustments made accordingly (mitigation planning).

There is a strong synergy between the PEMT, with its focus on the "risk register" and on driving mitigation actions, and the RPIT, with its focus on the visualisation and analysis of a database of "safety and risk indicators". When used together, they enable an approach whereby risk can be dynamically associated with the management of field development or operations, from a planning and execution perspective as well as from a performance and diagnosis standpoint.

References

1. The project execution management technology solution referred to as PEMT is this paper is known commercially as *PetrisWINDS Plan-IT* and commercialised by Petris Technology SAS.

2. The data visualisation technology solution referred to as RPIT is this paper described in this paper is know commercially as *PetrisWINDS Dashboard* and commercialised by Petris Technology SAS.

3. Shneiderman, B., Tree Visualization with Tree-Maps: 2-d Space-Filling Approach, ACM Transactions on Graphics (TOG), volume 11, number 1, pages 92-99, January 1992.

4. Wattenberg, M., *Visualizing the stock market*, Proceedings of extended abstracts on human factors in computing systems, ACM Press 1999, pages 188-189 (ISBN 1581131585).

5. Plaisant C., Chintalapani G., University of Maryland, Lukehart C., Schiro D., Ryan J., ChevronTexaco, *Using Visualization Tools to Gain Insight Into Your Data*, SPE 84439, SPE Annual Technical Conference and Exhibition 2003.

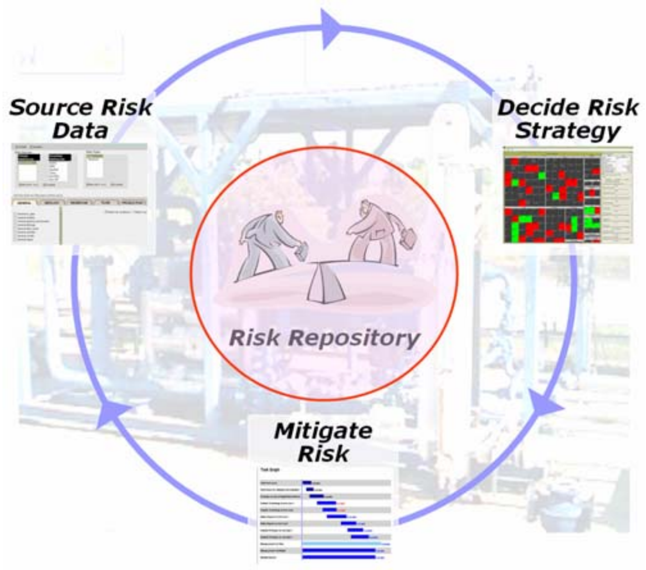

Figure 1 – Global Risk Management Approach

Risk

Hook-up work delays may cause overrun of offshore commissioning

Description:

This could interfere with operations, lower overall productivity, and cause delays to start of production.

Status: Open **Stage:** Evaluated

Visibility: 1 **Priority:** Low **Owner:** User Five

Start Date: 7/1/2006 **Target Date:** 31/3/2006 **Creator:** Risk Manager

Type: 01 - Project Organisation and Resources **Category:** Installation

Area: SURF

Comments

Comment	Owner	Edited Date
Origination - This Risk became an issue (occured) on peer review projects	Risk Manager	7/1/2006 1:12:04 PM
Fallback Plan - Contingency Plan CP-RPP-001	Risk Manager	7/1/2006 1:12:34 PM

Risk Assessment

Creator: Risk Manager **Assessment Date:** 7/1/2006 View History

Rev. No.	Rev. Date	Score	Probability	Schedule Impact	Cost Impact	Performance Impact	Revenue Impact
0*	7-1-2006	6*	Medium*	High*	High*	Low*	Low*

Next Steps

#	Description	Status	Owner	Target Date
129.1	Identification of commissioning packages that could be commissioned after start-up	In Progress	User Five	28/2/2006
139.2	Simultaneous operations procedures to be finalised	In Progress	User Four	31/1/2006
139.3	All Permits To Work to be fast-tracked	In Progress	User Thrre	31/3/2006

Figure 2 – Risk Identity Card

Risk Assessment 7/1/2006

Creator: Risk Manager **Assessment Date:** 7/1/2006

Assessment Line	Response	Score	Notes
Revision Number	0	0	Initial evaluation
Revision Date	7-1-2006	0	
Overall Score	6	6	Probability x Max (Impacts)
Probability	Medium	2	Review again after first set of mitigation actions performed
Schedule Impact Score	High	3	Impact is certain, but not that severe
Cost Impact Score	High	3	Penalties will be incurred
Performance Impact Score	Low	1	No real impact
Revenue Impact Score	Low	1	No real impact

Figure 3 – Risk Assessment Sheet

Figure 4 – Risk Register (extract)

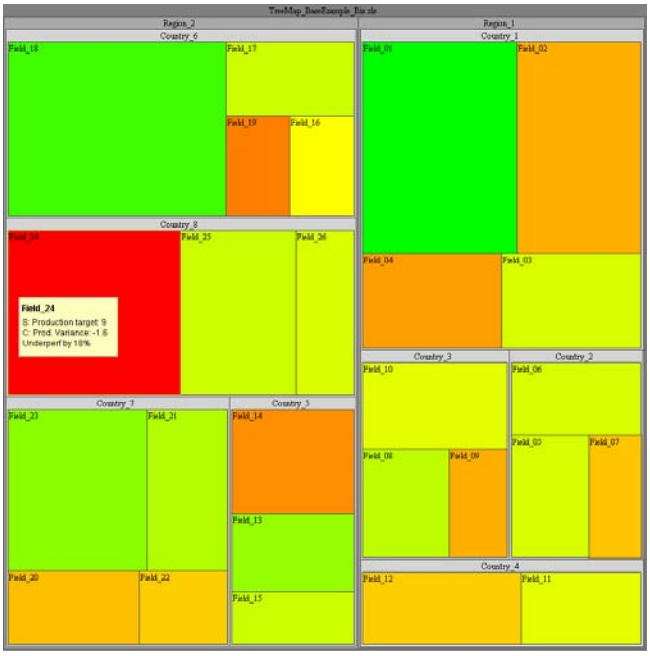

Figure 5 – Producing Fields Grouped Hierarchically by Country and Region.

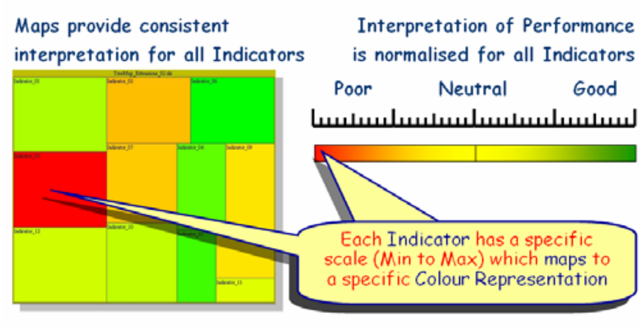

Figure 6 – **Example of Indicator Scale Normalisation**

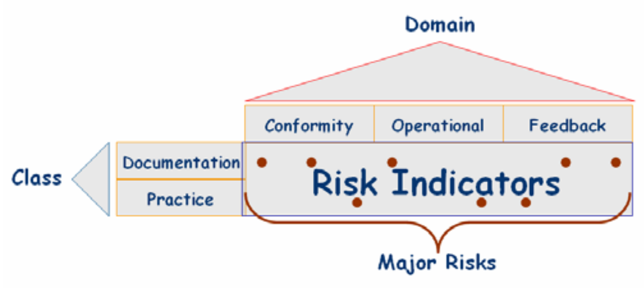

Figure 7 – **Example of Indicator Classification**

Figure 8 – **All RPIs, No "Importance" Criterion.**

Figure 9 – **All RPIs, Alternative Hierarchy, Major Risks have Increased "Importance" Criterion.**

Figure 10 – **Major Risks in "Practice" Domain Only.**