

A Detailed View of High Reliability Organization Models in the Oil Industry

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Abstract

Safety is considered a vital aspect of all projects and engagements in the oil & gas industry. It consists of operational tools and models that are utilized to mitigate accident occurrence and impacts. Currently, the human, technical and operational factors have well-developed tools and models for preventing and mitigating their occurrence and impact, leaving the organizational factors without a deployable model or tool. One of the models that are used nowadays in the industry is high reliability organization model. It provides the diagnosis of organizational reliability states and improvement opportunities in the complex, high-risk, error-prone upstream sector of the offshore oil & gas industry.

This model applies two analytical paradigms; the HRO scales audit and template analysis, which are quantitative and qualitative methods respectively. Both approaches were used to assess the organizational reliability state of a multinational oil and gas High Reliability Organization (HRO) having offshore projects in various regions across the globe. The paper proposes the utilization of this model for meeting the identified safety management use cases in the oil and gas industry which includes the safety first priority, activity-based safety cost reduction and contractor and supply chain safety management.

Keywords: HRO; Offshore projects; Safety management; Scales audit; Template analysis

Introduction

In 2015, British Petroleum (BP) Plc C-Suite executives received an additional claim of \$18.7 billion from the U.S government, increasing the Deep water horizon disaster clean-up and remediation penalties alone to \$54 billion [1]. For a high valued company, such penalty poses an acute difficulty on its corporate solvency whilst also facing low oil prices currently plaguing the industry. All these costs were incurred by just a single accident caused by technical factors (untested barriers) symptomatic of deep-rooted organizational factors National Commission [2]. The High Reliability Organizations (HRO) theory may offer a way forward in this regard. An HRO is an organization that consistently manages complex, high-risk, and error-prone systems safely, while HRO theory defines the organizational behaviours and culture necessary to deliver HRO performance [3]. A generic HRO model was developed by Weick and Sutcliffe's [4] called the HRO Scales audit. This model is arguably the first quantitative measure of organizational reliability. This paper undertook a literature review of the HRO theory, so as to identify the reliability-centred behaviours and organizational culture themes coded into the Weick and Sutcliffe [4] HRO Scales audit. A multinational oil and gas company with consistent, outstanding safety performance records was identified by the authors for the template analysis of its offshore projects and operations. One of the company's closest and most active regions having mostly offshore project activities; United Kingdom was selected for the analysis. The results of the revised HRO scales audit were matched against the repeating themes coded into the final template to ascertain the audit's predictive validity. To be able to deploy this new model, the final template was used to review the existing HRO audit scales metrics to make them more relevant and specific to the industry [5]. When this was done, the resulting HRO model became a quantitative analysis tool that could be used to provide an indication of the safety and reliability performance potential of organizations in the oil and gas industry.

Methodology

A systems approach to mixed methods analyses comprising qualitative and quantitative methods following the INCOSE 2015 Systems Handbook guideline, and following the V-systems design

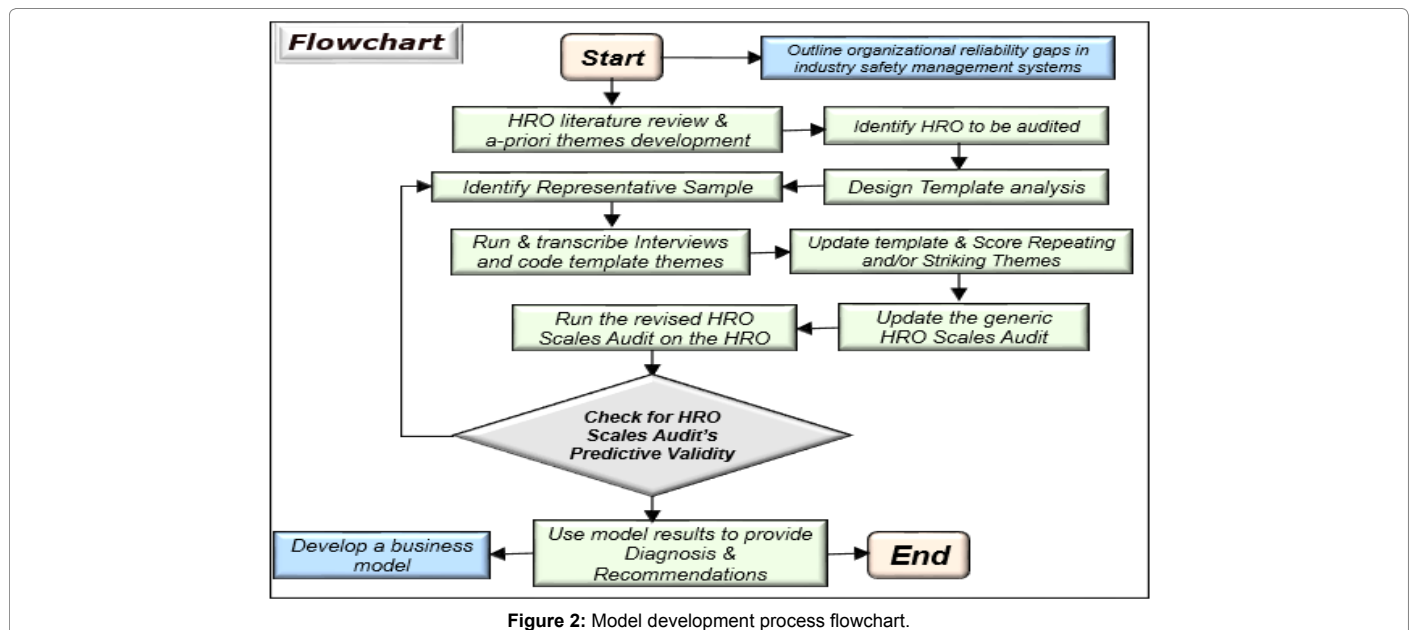
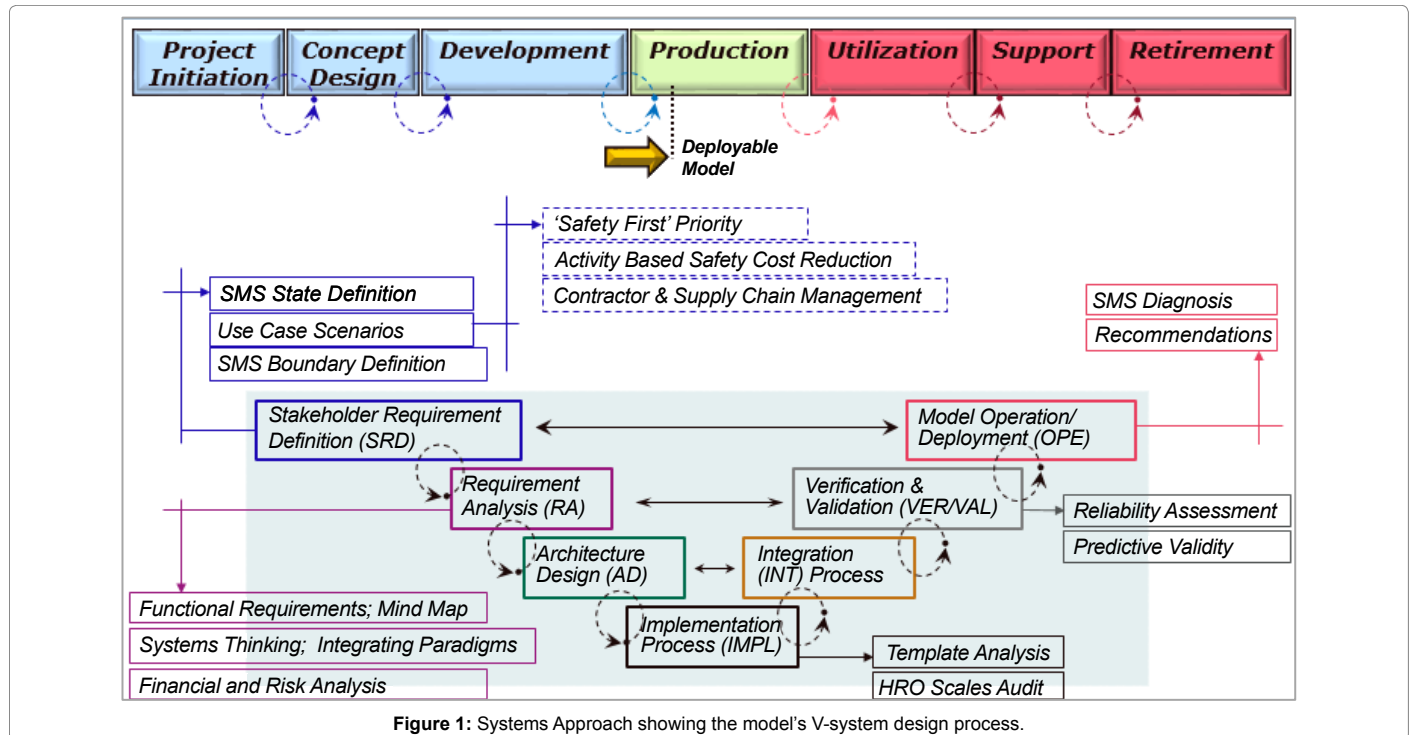
process was applied. Figure 1 below shows the systems approach applied in a snapshot, while Figure 2 shows the model design flowchart. Stakeholder Requirement Definition (SRD) consists of the definition of the current desirable system state and the opportunity framing of these requirements into use cases. Three major use cases for safety management in the oil and gas industry were identified, including the safety first priority, activity-based safety cost reduction, and contractor and supply-chain safety management (Figures 1 and 2). This was followed by a Requirement Analysis (RA) which is basically the process of categorizing and stating the HRO a-priori themes in a mind-map, and clearly defining the process by which the two paradigms; template analysis and HRO scales audit, are to be integrated using the systems thinking. It also involves a financial and risk analysis of the impact of achieving the pre-defined use cases. The Architecture Design (AD) was the next step, and involved defining the model work-flow process in a flowchart. The HRO scales audit; quantitative paradigm, presented in Weick and Sutcliffe was reviewed using the SRD, and ran on 60 respondents based on the same sampling criteria as the template analysis. A probabilistic sampling strategy was used for both the interviews and the HRO scale audit. For the interviews, the probabilistic sampling was based on the First in First out (FIFO) queuing theory until the number of individuals required in each predefined category is reached, while for the audit survey, every person invited to the survey by purposive sampling was allowed to respond before the date fixed to close the survey. Three sampling criteria were used for the purposive sampling of respondents and interviewees. They had to be in the upstream sector of the oil and gas industry and working or have worked offshore; directly responsible for or supporting key aspects of offshore project delivery; and comprising diverse years of experience, job groups and disciplines to capture systemic aspects around interfaces. The Integration (INT)

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process involved categorizing the main themes of both sub-models, so as to create two parallel assessment methods that can be compared for predictive validity, while the Verification and Validation (VER/VAL) process involved running pilot interviews and audits (surveys), doing independent assessment and verification of the whole systems analysis, and checking that the both paradigms produced same or similar results. This was followed by the model operation/deployment (OPE), which produces a diagnosis of the SMS reliability state complete with recommendations and improvement opportunities. This model can therefore be run on organizations within the oil and gas industry to assess their safety performance potentials, identify their organizational reliability state, and meet the three use cases described in the SRD.

Quantitative Paradigm - The HRO Scales Audit

The HRO Scales Audit is a quantitative assessment method following the method presented by Weick and Sutcliffe [4]. The audit scales are in three parts; preliminary assessment, five HRO principles and a summarized assessment; Mindful Organizing Scales (MOS). The questioning methods focus on organizational behaviours rather than on individual behaviours. The use of surveys that question organizational behaviours tend to provide more objective results as the pressures and biases of self-assessment is removed from individual respondents [6]. The preliminary assessment starts with the 'Mindful infrastructure' scale which comprises nine questions presented in a

'positive tone', with three answer options each. Each question is equally rated, providing a generic assessment template applicable for all types of organizations and industries. In summary, the 'Mindful infrastructure' scale is the statement 'We know our business is high-risk, so we are extremely careful!' The 'Vulnerability to mindfulness' scale is 'We do NOT easily identify lessons and learn from them!', while 'Requirement for mindfulness' is 'We do NOT have very complex human-system interfaces!', assessing how 'tightly coupled' and 'interactively complex' the systems in the organization are. To check for the very common survey bias of consistent positivity or negativity in respondents, the 'Vulnerability to mindfulness' scale is presented in a 'negative tone' [6]. The five HRO principles captures the main body of HRO audit scales as it covers the five HRO audit scales namely 'Preoccupation with failure', 'Reluctance to simplify', 'Sensitivity to operations', 'Commitment to resilience', and 'Deference to expertise'. It comprises 5 sets of questions summing up to a total of 48 questions with equal ratings, and 3 answer options each (Table 1).

Qualitative Paradigm – The Template Analysis

The template analysis method is the most suitable method for the flexible, mixed method approach that captures the research objectives. A few of the methods reviewed are the grounded theory, content analysis, template analysis, Interpretative Phenomenological analysis (IPA), and framework analysis. The template analysis method is the preferred method for running flexible, applied research using a-priori themes from previous studies and obtaining results in the shortest possible time [7]. Nigel King's Template Analysis is best suited for applied research that incorporates real-life experiences and feedback, and allows open-ended data with the opportunity for deepening

aspects of relevance to the research work by King [8]. Unlike other reviewed qualitative analysis methods, template analysis can be done in a relatively shorter time as it allows the use of a-priori themes and codes representing the practical issues driving the research work which has been compiled from available reviewed literature. It also allows the flexibility to incorporate fresh, more topical issues and new themes that expand on the a-priori themes to either sharpen an existing model for specific use or broaden it to make it more robust [7]. Template analysis is also perfectly suited for analysing HRO systems as it allows for overlapping themes, creating a network kind of interdependencies and interactions that are by no means linear; hence, suitable for real-life applications or situations. Care should be taken however, not to get the coding too nested that the interdependencies and interactions between the sub-themes become difficult to identify. For developing working models, it is very useful to first develop a mind-map of the themes, and define the nested relationships shown by the cross-category links; a typical whole systems analysis approach [7].

HRO Characteristics and Descriptions

The model design required the use of the High Reliability Organization (HRO) body of knowledge to define a-priori themes. These a-priori themes and the industry safety management use cases formed the basis for the development of the model interview questions. From about 30 years of organizational reliability research, a list of the desirable HRO behaviours and cultures was compiled, with the description of each behaviour shown in Table 2.

Conclusion

Accidents and serious issues could be disastrous to any business

Audit	Scales							Question
	Scores	9	10	11	17	18	27	
Mindful Infrastructure	Rating	0.33	0.37	0.41	0.63	0.67	1.00	+ ve
	Scores	8	9	10	16	17	24	
Mindlessness	Rating	0.33	0.38	0.42	0.67	0.71	1.00	- ve
	Scores	8	9	10	16	17	24	
Tightly coupled and Inter reactively Complex	Agree			Disagree				Indicative
Preoccupation with failure	Rating	0.33	0.40	0.43	0.67	0.70	1.00	+ ve
	Scores	10	12	13	20	21	13	
Reluctance to Simplify	Rating	0.33	0.42	0.44	0.67	0.69	1.00	+ ve
	Scores	12	15	16	24	25	26	
Sensitivity to Operations	Agree			Disagree				+ ve
Commitment to Resilience	Rating	0.33	0.42	0.44	0.67	0.69	1.00	+ ve
	Scores	12	15	16	24	25	26	
Deference to Expertise	Rating	0.33	0.38	0.38	0.67	0.71	1.00	+ ve
	Scores	7	8	8	14	15	21	
Mind full Organizing Scales (MOS)	Rating	0.33	0.37	0.41	0.63	0.67	1.00	+ ve
	Scores	9	10	11	17	18	27	

Table 1: Weick and Sutcliffe's (2007) HRO audit scales.

HRO Characteristics	Description
Definition	Describes the challenging environment HROs operate in Unexpected events are managed very frequently
Sudden unexpected Changes	Unexpected events often happen so fast, they leave little or no time for immediate human intervention.
Problem Anticipation	Managing of risks and failure modes, and being cognitive of all options and details of the work.
Pre occupation with Failure	Awareness of failure modes and actively monitoring the likelihood of failure
Risk Assessment	Identification, tracking and management of all possible technical and Operational Risks.
Proactive Audits	Proactively seeking for gaps in systems through inspection, testing and trials and providing the right equipment to maintain HRO safety performance.
Containment	Containing unexpected events as they happen, mitigating the impact and still function effectively.
Commitment to resilience	Clear steer and commitment to restoring normal operations when resilience unexpected events happen.
Deference to expertise	Ensuring people with the expertise on a subject respond to unexpected events.

Management support	When unexpected events start happening, frontline staff need to see a clear support from management, so as to make reasonable, safe decisions.
Mindful Leadership	Leadership that provides a clear goals, direction and oversight
Safety first	Leadership clarity and support of safety first in projects delivery and learning from incidents.
Management site visits	When senior managers in top management roles visit the frontline often and interact with workers, it keeps the frontline mindful and well supported to work more safely.
Management of change	Everyone in the organization is aware or can decide to be aware of ALL previous technical and operational changes, as these information are well managed.
Just Culture	Having a good balance between personal accountability and non-punitive stance on reported incidents.
Individual accountability	Everyone feels responsible and accountable for own and team member's safety.
No blame culture	No pointing of fingers when things go wrong, but taking the time to understand the precursors to the event and to learn from it as an culture organization.
Learning Orientation	Having systems that ensure lessons learned from experience of self and others is engrained in the organization, and mistakes do not get repeated.
Open communication	Openness to learning new things, irrespective of experience or expertise, and to share lessons learned with others in the organization.
Incident investigation	Investing time and resources to understand the root causes of incidents and the nested relationships with other enabling factors.
Learning from others	Learning from the experience and mistakes of other organizations and industries.
Organizational mindfulness	A strong sense of reliability-seeking behaviours across an integrated organization with an awareness of clear goals, and direction.
Organization-wide big picture	Everyone is made aware of the corporate priorities and goals, which are kept consistent.
Adaptive strategies	Adapting structured organizational systems to meet case by case requirements.

Table 2: HRO characteristics and description.

in the oil and gas industry. The existing safety management models and tools in the industry only cater for the human and operational factors of accident causation. This study has explained a model that assesses the third factor of accident causation; organizational, while also conducting a health-check of the whole safety management system complete with recommendations and improvement opportunities for the complex, high-risk, and error-prone upstream sector of the offshore oil and gas industry. This model was run on the HRO, a High Reliability Organization with consistent, excellent safety performance records. Two regions with huge portfolios of the HRO's offshore projects and operations were targeted for the analysis. The model applied two analytical paradigms; the HRO scales audit and the template analysis (quantitative and qualitative analysis), which provided results that can be compared to confirm the model's predictive validity. The striking feature of this model is that it clearly shows the strengths and the improvement opportunities in the safety management system of the HRO. The model helps to raise very specific red flags in organizational reliability long before they begin to be observed as incidents. Safety experts will find this analysis very useful for planning focused and targeted organizational safety management strategies which will both improve safety performance and reduce the cost of the usual blanket approach to safety management which is the current practice in the oil

and gas industry. Further research can also be carried out to incorporate the high impact, emergent consequences of cyber security on safety management system into the model.

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