MEASURING AND IMPROVING BLENDED PROJECT-SAFETY CULTURE IN OPERATIONS OF OFFSHORE OIL AND GAS FACILITIES

A Thesis

by

JUAN SEBASTIAN SERRANO DIAZ

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Chair of Committee,	Ivan Damnjanovic
Committee Members,	Ali Mostafavi
	H. David Jeong
Head of Department,	Robin Autenrieth

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ABSTRACT

The offshore oil and gas industry is a highly fragmented industry where contractors execute most everyday activities in all its phases. These contractors comprise around 80% of the personnel performing project activities in the different platforms and oil fields. Moreover, the personnel performing the activities are subjected to constant rotation due to the variety of activities. We can find modification, maintenance, repair, and testing among these activities. These situations present a challenge in which safety and project cultures must be adequately addressed while ensuring alignment between stakeholders.

To approach these challenges in the best possible way, the organization needs to perform some detailed analyses. These must identify the main drivers for the cultures and the stakeholders' performance while considering the dependencies and interactions between the project management culture and the safety culture. Also, interactions between the contractors' drivers and the operators' drivers need to be considered. The current work proposes a theoretical framework that measures the level of alignment between stakeholders and the expected performance for the project that is being conducted, based on the cultural status of the organization for both project and safety dimensions. In addition, the model supports the management of the offshore facilities by providing an additional tool that recommends several management strategies for improving the required processes during the operational phase of the platform, based on the assessment conducted previously.

DEDICATION

I would like to dedicate this work to my family: Libardo, Maria Cristina, Nanda, Maria, Leito, Gordo, Houses, Juanjo, Antonia, and Kike.

All their support and sacrifices enabled me the opportunity to achieve this goal. Thank you for your unconditional love and for always believing in me. I love you.

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This work was supervised by a thesis committee consisting of Professors Damnjanovic and Mostafavi of the Department of Civil & Environmental Engineering and Professor Jeong of the Department of Construction Science.

Discussions to gather expert knowledge and build upon safety management practices and project-safety interactions were carried out with the Proactima team, Dr. Damnjanovic, Dr. Mostafavi, and Dr. Walewski. All other work conducted for the thesis was completed by the student independently.

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1. INTRODUCTION

1.1. Background and Problem

The offshore oil and gas industry has always been an industry in which significant hazards (i.e., risky procedures, extreme weather, blowouts) are constantly present in their daily operations. These hazards sometimes materialize in many ways and with different associated impacts, ranging from a fire incident with minimum economic implications all the way up to explosions involving oil leakages and deaths such as Piper Alpha in the North Sea or Deepwater Horizon in the Gulf of Mexico. Improving the operator's safety culture and safety management strategies has been the standard approach to managing these situations. However, hazards are not only influenced by these aspects. These are highly related to the overall complexity in which operations are conducted. This complexity is driven by different operational, facility, and organizational attributes and characteristics. Thus, identifying the diverse drivers is critical to improving safety in the operations.

When identifying the drivers, two specific situations need to be considered. The first one is that after a facility is commissioned, several interfering activities such as modification, maintenance, repair, and testing are executed throughout the facility's operation. Therefore, their analysis should be done as mini-projects due to the need for a previously defined scope, schedule, and resource allocation. Hence, the project management approaches should not be considered to be organizational characteristics of the facility's operator. Instead, they must be analyzed independently for each specific contractor-operator society.

The second situation that needs to be considered is that there are multiple stakeholders in offshore operations. These stakeholders are mainly represented by contractors, comprising around 80% of the personnel involved in offshore oil and gas facility operations. Additionally, personnel come and go from the facility depending on the scope of activities that need to be executed.

These situations create a management challenge due to the mixed cultures generated by the interactions of various contractors with a unique operator. Also, these stakeholders might have different objectives for the project they are executing based on their organizational goals. For example, operators are more focused on adequate safety and productivity performance since they are the end responsible for the safety in the platform. In contrast, contractors are more concentrated on high performance in terms of cost and time relative to their specific activity since that is their profit generator.

Addressing this management challenge begins with answering the question, how can these multiple blended cultures be assessed? Since there might be different blended cultures operating simultaneously in the facilities, there appears the need for a holistic and systematic approach in which good alignment between contractors and operators is pursued while simultaneously managing the interactions between project and safety characteristics in the organization executing the mini-projects previously explained. An adequate model covering these criteria will help improve the performance of the oil and gas industry. Thus, the proper assessment and management of the blended cultures is the best way for enhancing the overall facility's performance, which is presented and tested in this thesis.

1.2. Thesis Objectives

Most safety improvement processes have been developed based on the idea that broad human and organizational factors are the main drivers of safety culture. Hence, managing safety as an independent entity is believed to be enough to improve personnel's behavior and the facility's performance. However, it has been theoretically proven by Damnjanovic and Røed (2016) that effective and well-planned work procedures reduce cost and improve safety, meaning that project management culture and safety culture are related. Thus, the assessment and management of the blended (Contractor-Operator, Project-Safety) cultures is the best way to improve the overall facility's performance.

This study aims to provide a theoretical framework that allows the measurement and improvement of the overall offshore facility culture by considering the interactions between project management and safety cultures. To this goal, the specific objectives of this research are as follows:

- Identify and model the critical success factors (CSF) required for having both adequate project management culture and safety culture independently.
- Identify and model the existing interactions between project and safety CSF, considering their strength and directions of impact.
- Develop a framework to measure and communicate the overall facility's status.
- Develop guidelines for measuring and improving the overall facility culture.

For this study, the critical success factors are defined as the features of projects that have been identified as necessary to be achieved to create excellent results (Rockart, 1979).

2. LITERATURE REVIEW

In the last decades, there has been much research effort regarding safety culture and its impact on different high-risk industries' safety management practices. In a broad sense, safety culture can be defined as a group of socio-psychological factors such as individual and group values, attitudes, and the resulting behavior determining the organization's commitment to safety (HSC, 1993). This commitment is also reflected in the formal dimension with the cultural influence towards the organization's safety prevention and control systems regarding competency and resource allocation (Al Haadir & Panuwatwanich, 2011).

One of the industries leading these efforts has been the oil and gas industry due to its complexity and the consequences of the incidents and accidents that might occur during its operations. Working on improving organizational and safety management practices has been the main focus. Thus, several authors have conducted studies to identify soft aspects of safety performance across different cultural, human, organizational, and behavioral dimensions. Also, they have conducted studies to evaluate the success of varying safety management interventions.

Regarding aspects associated with safety performance, specific studies were found to be significant. For example, Gordon (1998) analyzed the contribution of human characteristics to accidents in the offshore oil industry and their involvement in both active and latent errors. Mearns, Flin, Gordon, and Fleming (2001) also studied human and organizational factors in offshore safety, finding that unsafe behavior is the "best" predictor for accidents. Antonsen (2009) evaluated power and conflict issues and their

importance when studying an organization's safety culture to avoid authoritarian safety doctrines due to their associated risk. Finally, O'Dea and Flin (2001) evaluated the implications of managers and their leadership in the safety performance of the offshore oil and gas industry, finding that overestimating their ability to influence and motivate the offshore workforce sometimes generates undesired conditions in which personnel is not highly involved in safety management procedures.

Regarding the evaluation of safety management interventions, studies were focused on more tangible and measurable aspects. For example, Antonsen, Almklov, and Fenstad (2008) evaluated the impact of adequate procedure planning and implementation on safety performance. The main finding was that promoting worker participation in the development of procedures increases the commitment level of personnel and, hence, adherence and compliance to procedures and documentation, which generates a better safety culture. Moreover, Hauge and Øien (2016) developed practical guidance on barrier management, focused on systems and solutions for maintaining adequate barriers over the lifespan of the offshore facilities. This study was conducted with the primary purpose of reducing accident risk in the Norwegian petroleum industry. From all these studies, it can be seen that safety culture has become an all-embracing term for analyzing safety performance (Guldenmund, 2000).

In Addition, several studies have been conducted to analyze past incidents to identify the common causes between them and learn from these failures. For example, Halim, Janardanan, Flechas, and Mannan (2018) found that almost 70% of the fires occurring in offshore oil and gas facilities happen during the production phase while

having job safety analysis, procedure, and maintenance-related issues at the top contributors for those incidents.

However, all these studies have not analyzed safety as an aspect directly related to the project management culture conducting the project activities. Moreover, almost all project management and project success studies have also been conducted without considering safety as an essential and specific aspect for project performance and success. This has always been analyzed focused on the achievement of cost, quality, and time objectives. Due to this, research regarding project culture and project success has been focused mainly on identifying the adequate drivers for management success.

For this, research has been divided into two groups. The first one is focused on the critical factors required for project success, and the second one on the organizational culture associated with projecting management. Regarding critical success factors, Pinto and Slevin (1987) and Pinto and Prescott (1990) have conducted significant research to establish the ten most important factors that need to be considered across the entire life cycle of a project for it to be successful. Pinto and Prescott (1988) also analyzed how the importance of these critical factors changed based on the project life cycle stage that was being analyzed. Finally, Tsiga, Emes, and Smith (2017) conducted a study to evaluate different critical success factors in the petroleum industry. Factors were first identified from existing literature and then tested in the petroleum industry using available data from several projects. Project Manager Competence, Project Risk Management, and Requirements Management became some of the most critical aspects of successful petroleum projects.

On the other hand, regarding the organizational culture, Hoole and Du Plessis (2002) presented a questionnaire for defining the project culture of any organization by considering eleven elements that are believed to capture the essence of the organization relative to its people, systems and structures, processes, and the environment. Additionally, Brown (2008) conducted a theoretical study in which fourteen dimensions of an organizational culture supportive of project management were identified. These dimensions are mainly associated with the manager's style and project team performance. They are framed in a way that their presence promotes managerial excellence in the project organization.

As established before, studies to analyze project culture and safety culture have been conducted independently. Hence, no research has been shown to evaluate the interactions between project management culture and safety culture so that the organizational analysis regarding safety will be performed holistically. However, Damnjanovic and Røed (2016) demonstrated the importance of planning as part of major accident prevention activities. Based on this initial approach towards a significant relationship between project management and safety, this study aims to provide a theoretical approach to these interactions and close the existing gap between related project and safety culture research.

3. CONCEPTUAL FRAMEWORK AND PROPOSED USE

In this section, the conceptual framework used for the model development and its proposed use will be presented. The section is divided into three separate segments: (1) presents the general framework with the hierarchical structure assumed for the model, (2) presents the pentagon model upon which the critical success factors identification is based, and (3) presents the proposed workflow for the framework.

3.1. General Framework for Modeling

The general framework for measuring the organizational status regarding productivity and safety performance is considered a hierarchical structure with well-defined levels and characteristics. This structure defines how the information flows. The assessments aggregate throughout the model from the base level to the top level. Thus, the base level is identified as the critical success factors (CSF) measured and analyzed. The top-level is identified as the final performance of the organization.

This framework also defines how the project and safety culture are interrelated and affected by each other. Interactions are considered at the CSF level, where the observable characteristics are assessed. Additionally, the presence of each CSF is influenced by the contractor and the operator executing the project, as well as by specific traits associated with the project and facility type. Figure 1 shows the conceptual framework considered for the development of the model.

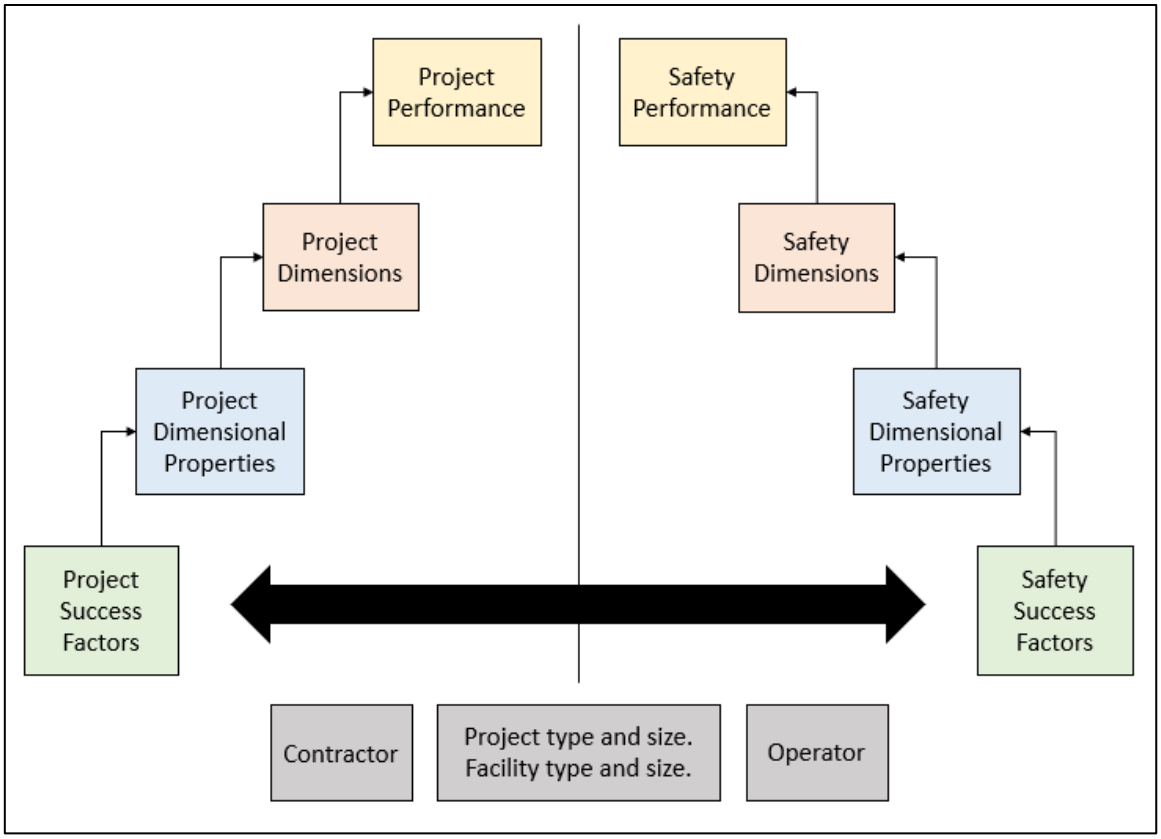

Figure 1. Conceptual Framework for Measuring Blended Culture

3.2. The Pentagon Model

The "Pentagon Model," developed initially by Schiefloe (2011) and then adapted by Rolstadås et al. (2014), is the model used to identify the critical success factors for both safety and project performance, independently. This model allows holistically evaluating the organization since it considers formal and informal qualities of the organizations and relations with the project context and external stakeholders. Figure 2 illustrates the proposed adaptation from the model to analyze the organizations in terms of their capabilities and performance.

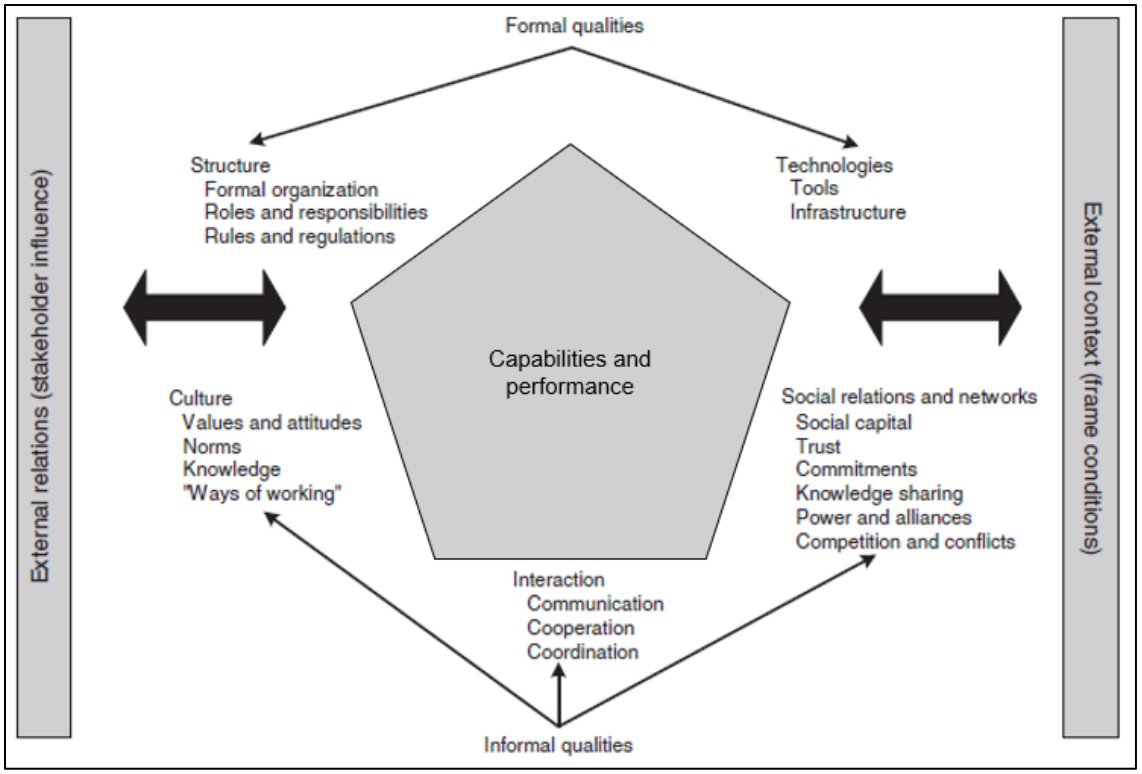

Figure 2. Pentagon Model. (Modified from Rolstadås et al. (2014))

The pentagon model analyzes the performance around five different aspects of the organization. As explained by Rolstadås et al. (2014), the scope of each dimension is the following:

- Structure: Defined roles, responsibilities, authority in the formal organization, defined procedures, regulations, and working requirements.
- Culture: Language, values, attitudes, norms, knowledge, and the ways of working expected by the organization.
- Technology: Tools, technologies, and infrastructure upon which the personnel depend and use to execute the project activities. It also includes communication and collaboration technologies.

- Interaction: Communication, collaboration, cooperation, and coordination between the organization's personnel. Management practices and the flow of information are also included in this aspect.
- Social Relations and Networks: Trust, friendship, access to knowledge and experiences, informal power, alliances, competition, and conflicts. These represent the social capital of the organization and how they build the informal structure.

Additionally, the analysis provided by the model considers the fixed context in which the project organization is working and the input from external stakeholders. The critical success factors are identified accordingly to cover the previously stated and defined organizational aspects and the external influences.

3.3. Framework's Proposed Workflow

The proposed use for the framework being developed is to work as an alignment tool between the operator and contractor in charge of the project. Hence, it manages the interactions between the project and safety culture. In addition, the idea for the framework is to be used before starting the execution of the project in the onboarding processes so that improvement measures can be taken promptly. Figure 3 presents the proposed workflow for the framework implementation.

The contractor acts as the main responsible for the project culture since it leads the execution of the activities. Conversely, the operator serves as the main responsible for the safety culture since it is the end accountable if an accident occurs in the platform. Therefore, both the operator and the contractor first analyze the organizational

characteristics and the execution and safety risks associated with the work scope and the facility.

With this done, a workshop is conducted, and the inputs are provided to the tool jointly. Results are obtained for both project and safety status, and hence misalignment is evaluated. Since results are generated for the five different dimensions of the pentagon and the overall status, deficiencies can be individualized, and management strategies specified depending on the main focus decided by the contractor-operator team. If the project executed has a long-term schedule, a reassessment is proposed after implementing the management strategies to evaluate the level of improvement that might have occurred in the organizational status.

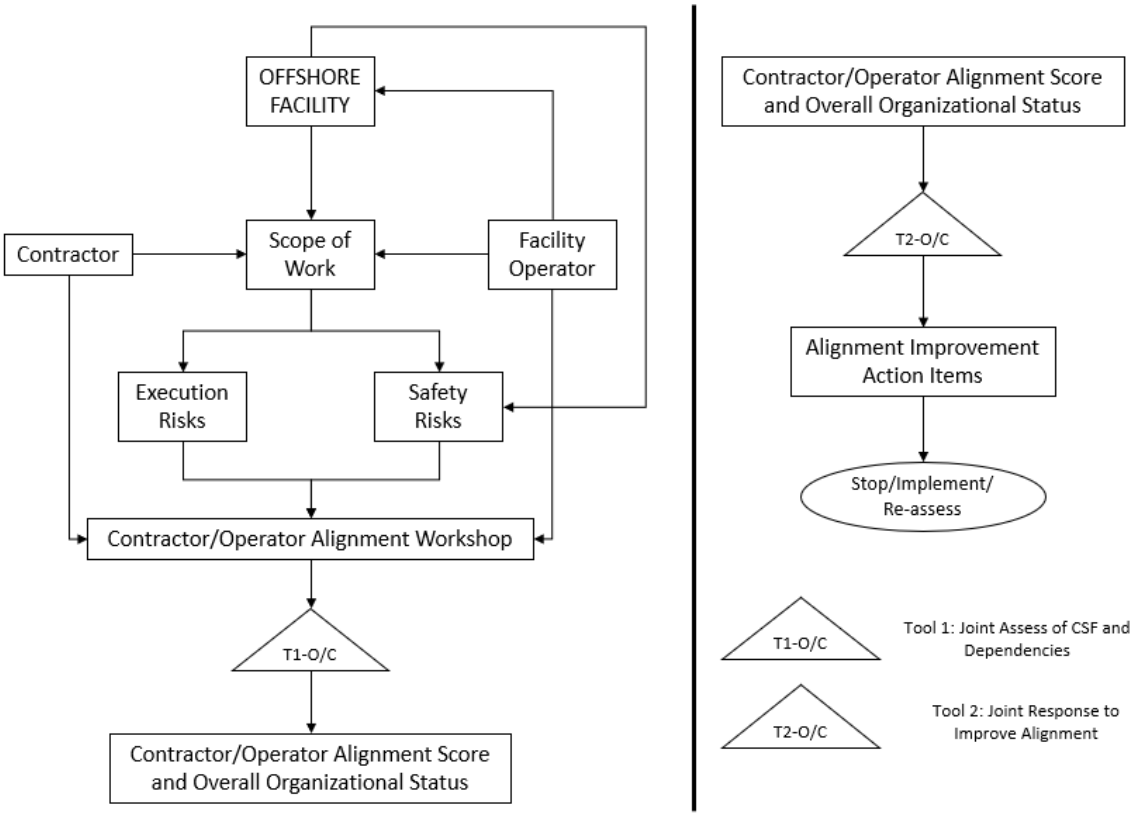

Figure 3. Tool's Proposed Workflow

4. METHODOLOGY

In this section, the methodology used to develop the assessment model will be presented. The methodology is divided into seven separate segments: (1) presents project/productivity success factors identification and characterization, (2) presents safety success factors identification and characterization, (3) shows the theoretical interactions between project and safety success factors, (4) shows the network-based approach used to transform the general framework and capture the information flow, (5) presents the importance of each element in each hierarchy level of the network, (6) describes the calculation procedure to evaluate the organizational status based on the assessment of the CSF, and (7) discusses the identification of management strategies for the CSF.

4.1. Project / Productivity Success Factors

The project performance is evaluated regarding the facility's productivity, including scope, time, and cost compliance. The pentagon model was used to identify the dimensional properties unique to each dimension that best describes the organization's capabilities towards these end goals. Simultaneously, a thorough literature review was conducted regarding critical success factors both for project success and ensuring an organizational culture supporting business success.

Multiple success factors have been previously identified. Pinto and Slevin (1987) identified ten different factors predictive for project success, which are general enough to be applicable to any type of project and organization. These factors were Project Mission, Top Management Support, Schedule and Plans, Client Consultation, Personnel, Technical Tasks, Client Acceptance, Monitoring and Feedback, Communication, and

Troubleshooting. Hoole and Du Plessis (2002) and Brown (2008) identified the main characteristics and dimensions that capture the essence of the organizational culture and support a good project management approach. Among these characteristics and dimensions were Member Identity, Management Focus, Unit Integration, Risk Tolerance, Conflict Tolerance, Control Mechanisms, Open-System Focus, Means Versus End Orientation, Employee Participation, and Disposition Towards Change.

Finally, Rolstadås et al. (2014) identified nine success factors present in a successful oil and gas project in Norway through implementing the pentagon model. Among these factors, there was Project Tools, Risk Management, Recruitment Strategy, Existing Relations, Contract Strategy, Aligned Governance, and Stakeholder Management. All these factors were cross-checked with the aspects comprising the dimensional properties. The finalized list of critical success factors for project performance and their relationship with each pentagon dimension is shown in Table 1. The definitions for the dimensional properties and the critical success factors are listed in Appendix A.

Table 1. Critical Success Factors for Project Performance

Dimension	Dimensional Property	Critical Success Factor
Structure	Defined Organizational and Project Structure	Clear Responsibilities
		Governance and Contracting Structure
		Project Mission (Objectives)
	Resource Management	Project Schedule / Plan
		Competent Personnel
	Incentive Structures	Reward Criteria

Table 1. Continued

Dimension	Dimensional Property	Critical Success Factor
Culture	Goal Oriented Ways of Working	Ends Orientation
		Risk Tolerance
		Trouble Shooting
	Value Alignment	Management Focus
		Member Identity
Technology	Adequate Project Tools	Well-Proven Project Management and Communication Tools and Technologies
		Sufficient / Well Allocated Resources
Interaction	The Four Cs	Unit Integration
		Open-System Focus
		User / Client Involvement
	Team Management	Competent Project Manager
		Monitoring and Feedback
Social Relations & Networks	Committed and Trusted Social Capital	Top Management Support
		Competent Personnel
	Behavioral Agreement	Control Mechanisms
		Conflict Tolerance

4.2. Safety Success Factors

The safety performance is evaluated regarding the facility and organization's ability to prevent major accidents during the operational phase. The pentagon model was used to identify the dimensional properties unique to each dimension that best describes the organization's capabilities towards these end goals. Simultaneously, a thorough literature review was conducted regarding the contribution of human and organizational factors to safety management practices in the offshore industry and the causes of accidents established in previous accident investigations and reports.

Multiple causes and factors contributing to minor and major accidents have been previously identified. For example, Mearns, Whitaker, and Flin (2003) identified how several health and safety elements such as Health and Safety Policies, Workforce

Involvement, Management Commitment, Health Promotion and Surveillance, and Health and Safety Auditing are associated to sound safety performance in several offshore organizations. Gordon (1998) studied how different underlying causes related to organization, group, and individual factors contribute to accident occurrence. These causes included Knowledge and Skill, Role Knowledge, Stress, Improper Motivation, Supervision, Procedural Management, Decision-Making, and Communication.

Finally, Halim, Janardanan, Flechas, and Mannan (2018) studied several offshore incident reports to identify common causes among them. Among the most important causes identified were Improper Job Safety Analysis, Improper Communication, Improper Procedure, Improper Equipment, Inadequate Isolation, and Lack of Maintenance. All the causes and accident factors were then transformed into measurable success factors. These factors were then cross-checked with the aspects comprising the dimensional properties. The finalized list of critical success factors and their relationship with each pentagon dimension is shown in Table 2. The definitions for the dimensional properties and the critical success factors are listed in Appendix A.

Table 2. Critical Success Factors for Safety Performance

Dimension	Dimensional Property	Critical Success Factor
Structure	Role Clarity and Balance	Organization Chart Clarity
		Role Clarity
		Role Balance
		Governing Documentation
	Incentive Criteria	Incentive Criteria
	Resource Management	Resource Management
Culture	Competence	Competence
	Values (Actual)	Value Alignment
		Learning From Previous Failures

Table 2. Continued

Dimension	Dimensional Property	Critical Success Factor
Technology	Inherent Safety	Inherent Safety
		ICT Architecture
Interaction	Cooperation	Communication
		Cooperation
	Leadership in Safety	Resource Allocation
		Leadership in Safety
Social Relations & Networks	Commitment to Governing Documentation	Resource Access
		Commitment to Governing Documentation
		Trust
	Goal Balance	Power
		Goal Balance

4.3. Project and Safety Interactions

As stated previously, offshore activities are carried out in the context of "mini-projects," in which a constant blending of cultures is present. For assessing this, interactions between project/productivity culture and safety culture were considered. The interactions analysis is carried out to identify the converging and diverging factors between project and safety cultures, meaning that it was done at the critical success factors level since it is where the observable characteristics of the organization are.

The interactions influence the other's culture, hence the organization's performance in terms of productivity and safety. Due to this, the joint analysis was performed considering the direction and the effect of the influence between the CSF. A dependency matrix approach was used for it. Table 3 shows an extraction of the matrix evaluating the impact of project success factors over safety success factors. The full matrices for both directions are shown in Appendix B.

Table 3. Dependency Matrix Extraction for Factors Interactions

		SF1	SF2	SF3	SF4	SF5
		Organization Chart Clarity	Role Clarity	Role Balance	Governing Documentation	Incentive Criteria
PF1	Clear Responsibilities	+	+			
PF2	Governance and Contracting Structure	+	+	+	+	+
PF3	Project Mission					+
PF4	Project Schedule / Plan					
PF5	Competent Personnel					

The matrix is interpreted as follows:

- The CSF in the rows influences the associated CSF in the columns.
- The color indicates the existence of relations between the CSF. Green means the certainty of the link. No color indicates no relationship between the CSF.
- The sign indicates if the CSF located in the rows promotes or worsens the CSF located in the columns. (+) means promotion, while (-) means worsening.

The evaluation of the interactions was done based on an extensive literature review regarding safety culture and project culture, considering the scope of each CSF. Additionally, subject matter expert knowledge was considered and obtained from internal discussions between the project team. The graphical representation of all hypothesized interactions is shown in Figure 4. A total of 236 interactions were identified. Safety success factors are presented on the left side of the figure. In contrast, project success factors are shown on the right side.

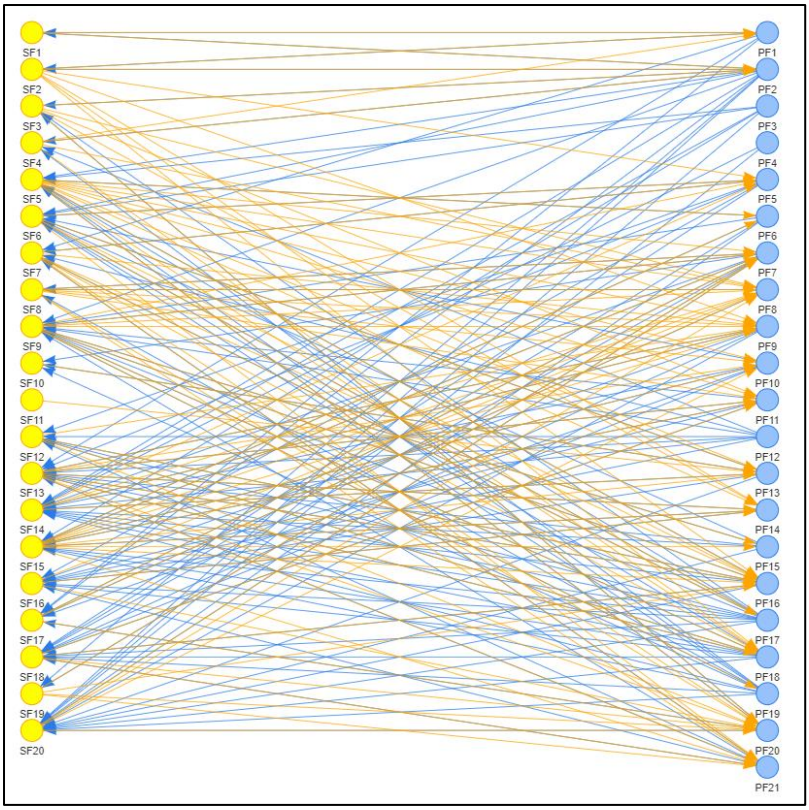

Figure 4. Graphical Representation of Hypothesized Interactions

4.4. Network-Based Model

A network-based model is used to capture the information flow and the interactions between CSF adequately. This approach is supported by the idea that complex project organizations are conceptualized as complex networks consisting of nodes and edges defining interconnected features such as tasks, agents, information, and resources (Sterman 1992, Baccarini 1996, Pfeffer and Carley 2012). The CSF, dimensional properties, pentagon dimensions, and associated ending performance are modeled as nodes containing the visible information and the current status of the features from the project organization. On the other hand, the information flowing from one level to another, considering direction, strength, and effect, represents the edges.

The network-based model for the blended culture assessment model is shown in Figure 5. The blue nodes represent the CSF for both project and safety performance. The yellow and fuchsia nodes represent the dimensional properties for project and safety, respectively. The red and purple nodes represent the pentagon dimension for project and safety, respectively. Finally, the green and orange nodes represent the resulting organizational performance regarding project and safety, respectively.

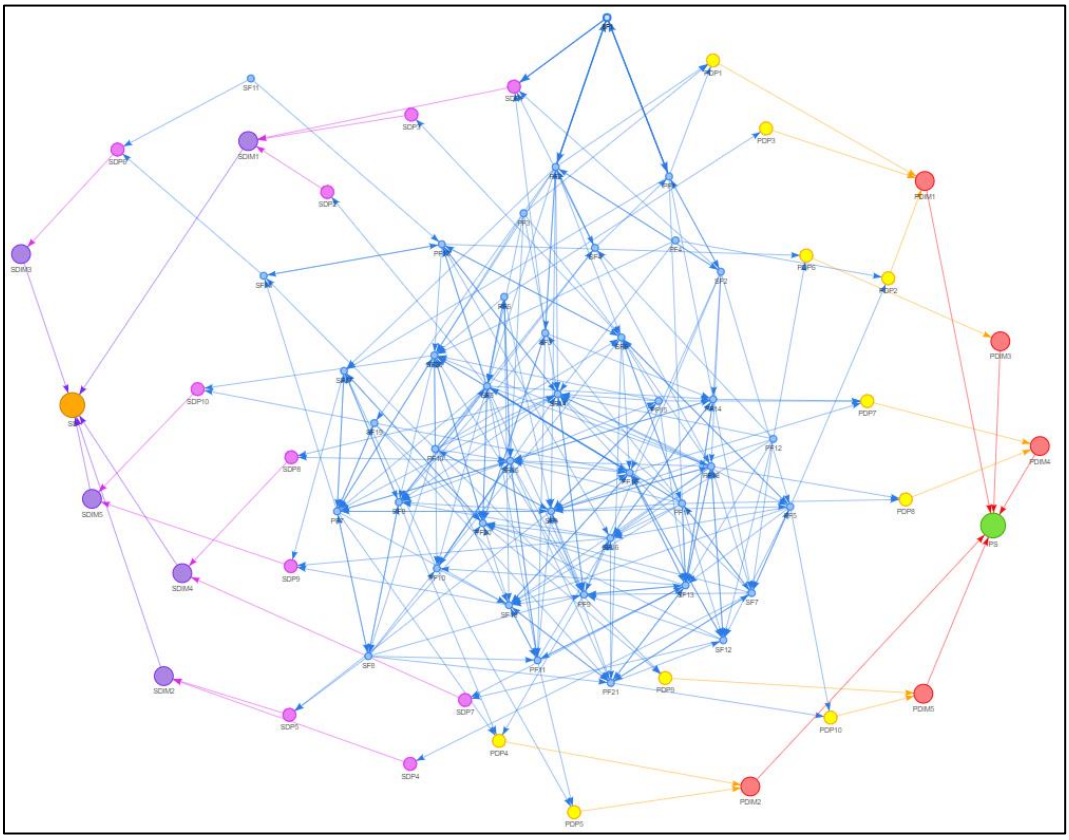

Figure 5. Network based Model for Assessment of Blended Culture

4.5. Calculation of Links' Weights for Network

The importance or weight of the different edges in the network is established to adequately evaluate each CSF's contribution towards the organization's final performance. The selected procedure was the analytic hierarchy process (AHP) due to the model's

hierarchical nature. It is done by performing pairwise comparisons between nodes regarding their relative importance to the upper-level node they are "feeding." AHP analysis is carried out using the procedure developed by Saaty (1980). The basic process for AHP with its specifics is described next, and it is done relative to Figure 6.

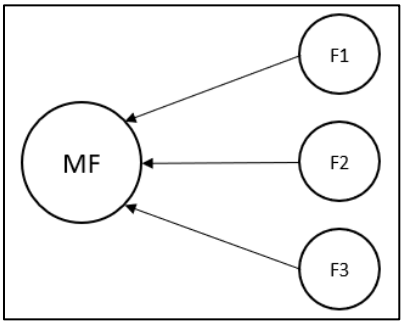

Figure 6. Sample Hierarchical Structure

Figure 6 presents a sample hierarchical structure where F1, F2, and F3 are the subfactors of the more significant factor MF. The first step is to develop the pairwise comparison matrix for each element being analyzed. This has the matrix form shown in Equation 1, and the comparison scale used is shown in Table 4. The upper diagonal of the matrix is evaluated first. Then the lower diagonal is filled with the reciprocal values of the upper comparison.

$$\begin{bmatrix} F_{11} & F_{12} & F_{13} \\ F_{21} & F_{22} & F_{23} \\ F_{31} & F_{32} & F_{33} \end{bmatrix} \quad (1)$$

Table 4. Fundamental Scale for Comparison (Saaty, 1980)

Scale	Degree of Preference
1	Equal importance
3	Moderate importance of one factor over another
5	Strong or essential importance
7	Very strong importance
9	Extreme importance

Next, the normalization of the resulting matrix occurs to generate the final vector with the associated weights of the elements. Finally, each element of the pairwise comparison matrix is divided by the column total to generate a normalized pairwise matrix. Equation 2 shows the associated calculation and the form of the resulting matrix.

$$X_{ij} = \frac{F_{ij}}{\sum_{i=1}^{n} F_{ij}} \qquad \begin{bmatrix} X_{11} & X_{12} & X_{13} \\ X_{21} & X_{22} & X_{23} \\ X_{31} & X_{32} & X_{33} \end{bmatrix} \tag{2}$$

With this, the resulting vector with the associated weights for each factor is generated. This is done by dividing the row total of the normalized matrix obtained in Equation 2 by the number of factors (n) used to create the comparison matrix. Equation 3 shows the associated calculation and the form of the resulting weight vector.

$$W_{ij} = \frac{\sum_{j=1}^{n} X_{ij}}{n} \qquad \begin{bmatrix} W_{11} \\ W_{21} \\ W_{31} \end{bmatrix} \tag{3}$$

Having the weights calculated, a final consistency analysis is conducted to evaluate the applicability of the resulting weights. First, a consistency vector is calculated by multiplying the pairwise comparison matrix by the weights vector and dividing the weighted sum vector by the resulting vector obtained in Equation 3. This process is presented in Equations 4 and 5.

$$\begin{bmatrix} F_{11} & F_{12} & F_{13} \\ F_{21} & F_{22} & F_{23} \\ F_{31} & F_{32} & F_{33} \end{bmatrix} * \begin{bmatrix} W_{11} \\ W_{21} \\ W_{31} \end{bmatrix} = \begin{bmatrix} Fv_{11} \\ Fv_{21} \\ Fv_{31} \end{bmatrix} \tag{4}$$

$$Fv_{11} = \frac{Fv_{11}}{W_{11}}$$
$$Fv_{21} = \frac{Fv_{21}}{W_{21}} \quad (5)$$
$$Fv_{31} = \frac{Fv_{31}}{W_{31}}$$

With this, the vector's consistency index (CI) is calculated to measure deviation in the consistency vector generated in Equation 5. The associated calculation is shown in Equation 6.

$$CI = \frac{\sum_{i=1}^{n} Fv_{ij} - n}{n - 1} \quad (6)$$

Finally, the consistency ratio (CR) is calculated to evaluate how consistent are the comparisons performed at the beginning of the process. Having a CR of less than 0.1 means that the comparisons are consistent, and hence, the weights are acceptable for implementation. Equation 7 shows the associated calculation.

$$CI = \frac{CI}{RI} \quad (7)$$

In there, the RI represents an average random consistency index of randomly generated reciprocal matrices. Table 5 shows the random inconsistency indices used for the AHP process.

Table 5. Random Inconsistency Indices (Saaty, 1980)

N	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.46	1.49

N	11	12	13	14	15	16	17	18	19	20
RI	1.51	1.54	1.56	1.57	1.58	1.6	1.61	1.62	1.63	1.63

The AHP process explained before was conducted for all the critical success factors, dimensional properties, and dimensions/aspects of the entire network. Comparisons were made based on the scope of each element and considering extensive literature reviews and internal discussions between the project team.

Additionally, some assumptions were considered. The first assumption was that based on the pentagon model, all dimensions/aspects have equal importance towards the overall organizational performance. For this, each dimension will contribute 20% towards the overall status. The second assumption was that the combined evaluations of the factors were modeled as temporal hierarchical structures. The independent assessment for both project and safety factors is at the lower level. The independent assessment of the factor for which the temporal hierarchy was created was considered the leading contributor for the final combined status. The final combined status of each critical success factor is at the upper level.

Figure 7 shows an example of these temporal hierarchies. It can be seen in this example that the combined evaluation of “Safety Factor 1” is done by considering the independent assessment of this same “Safety Factor 1” and the independent evaluations of the influencing factors that come from the project side, which in this case are “Project Factor 1”, and “Project Factor 2”.

1	SF1. Organization Chart Clarity
2	PF1. Clear Responsibilities
3	PF2. Governance and Contracting Structure

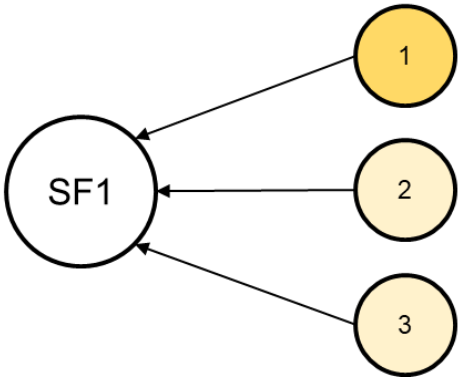

Figure 7. Sample Temporal Hierarchical Structure

These temporal hierarchies were then used to evaluate the weights of each interaction. As said before, the major factor's independent assessment was considered the leading element in the lower level of the hierarchy. In this case, “SF1” was given a status of extreme importance over factors “PF1” and “PF2”, which are the ones that influence from the project side. Factors “PF1” and “PF2” were assigned equal importance between them. This assumption was applied to all the combined evaluations and without any difference associated with the number of factors influencing the other side.

The weights obtained were organized in a table format so that the posterior calculation procedure was easier to manage. Table 6 shows an extraction of the relative distribution of weights obtained for the project culture elements concerning the structure dimension. The complete tables for both project and safety elements are shown in Appendix C.

Table 6. Extraction of Weights for Project Culture

Dimension	DP Weight	Dimensional Property	CSF Weight	Critical Success Factor
Structure	63.33%	Defined Organizational and Project Structure	33.33%	Clear Responsibilities
			33.33%	Governance and Contracting Structure
			33.33%	Project Mission (Objectives)
	10.62%	Resource Management	75.00%	Project Schedule / Plan
			25.00%	Competent Personnel
	26.05%	Incentive Structures	100.00%	Reward Criteria

4.6. Calculation Procedure and Displaying of Results

The organizational status is calculated by considering the hierarchical structure, interactions of factors, and importance of network links. This calculation procedure starts with the individual evaluation of the project and safety success factors identified in sections 4.1 and 4.2, respectively. The evaluations are done considering the scope of each CSF and the presence level considered by the organization's personnel conducting the assessment. The level of presence is evaluated using a Likert scale ranging from 1 to 7, which is then transformed to provide a final score ranging from 0 to 100. Table 7 shows an example of the CSF evaluation.

Table 7. Example of CSF Evaluation

Critical Success Factor	Level of presence, from 1 to 7.	Final Score
Clear Responsibilities	5	71.43
Governance and Contracting Structure	3	42.86
Project Mission (Objectives)	5	71.43
Project Schedule / Plan	6	85.71

The score of each CSF is propagated throughout the network by aggregating the different weights calculated in section 4.5. These scores are propagated relative to each

pentagon dimension and the ending organizational status for both project and safety status. The results obtained by aggregating the different weights and propagating the evaluations of the CSF are displayed in two different ways. The first one is through a spider diagram, in the form of a pentagon, showing each dimension's status. The second one is through a score meter with the overall status towards success. These can be seen in Figures 8 and 9, respectively. The scale of blue represents the road to success status, with lighter blue meaning that it is in a position towards failure. In contrast, darker blue means that it is in a place towards success.

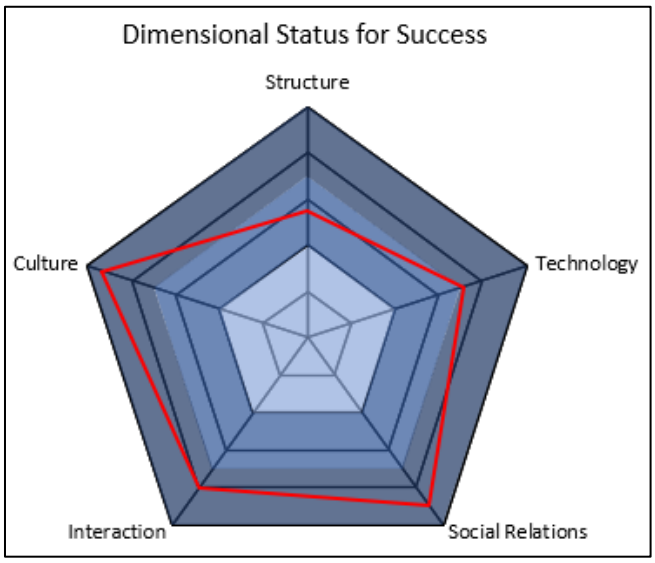

Figure 8. Example of Spider Diagram Results

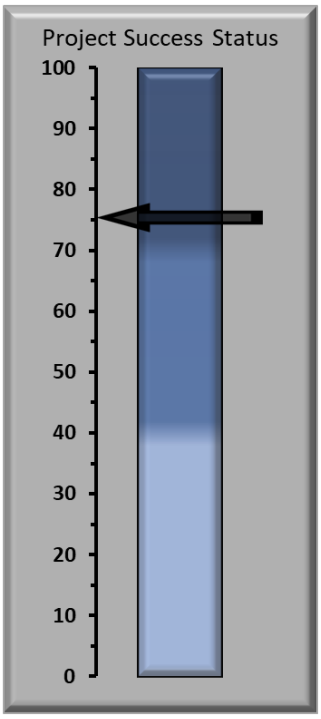

Figure 9. Example of Score Meter Results

4.7. Management Strategies for Improvement

Several management strategies are presented following the end goal of the research, which includes improving the blended culture status of the organization. The need for these strategies is identified with the results generated in section 4.6. Depending on these results and considering the aggregated impact identified in section 4.5, the critical success factors with the most significant capacity for improvement are targeted.

The strategies were built upon the identification of specific contributors that define each critical success factor. For each contributor, several statements were established to facilitate their evaluation in a more detailed way. The management statements were structured by analyzing specific industry characteristics and existing datasets already implemented in previous studies. The existing datasets considered were:

- Risikonivå i norsk petroleumsvirksomhet (RNNP) dataset.
- Project Culture Assessment dataset. (Du Plessis, 2004)
- Project Implementation Profile dataset. (Pinto, 1990)

These statements are analyzed in the form of a check box to identify the issues and the recommended solutions. Table 8 presents the contributors and statements for CSF named "Clear Responsibilities." The management strategies for all the project and safety factors are shown in Appendix D.

Table 8. Example of Management Strategies

CSF	Contributor	Management Statements
Clear Responsibilities	Role Definition and Clarity	Job descriptions for each team member's role have been specified, written, and distributed.
		The division between operational and project responsibilities is clearly defined.
		Differences between the different roles in the organization are clearly specified.
	Role Understanding	The personnel understands their specific tasks for the project.
		Each team member knows exactly what he/she is responsible for in the project implementation.
		Personnel knows what to do in an emergency situation.
		Personnel knows who in the organization to report to.
		Each team member has a clear understanding of his/her role in the team.

5. CASE STUDY

This section presents a hypothesized case study to demonstrate the developed framework for measuring and improving the blended project-safety culture. The case study is divided into five separate segments: (1) Presents a brief context of the case study, (2) presents the random inputs provided for the hypothesized case related to both project and safety culture, (3) displays the outputs obtained from the initial evaluation and their associated analysis, and (4) shows the posterior evaluation after management strategies are implemented, and processes are improved.

5.1. Context of Case Study

The hypothesized case consists of an offshore facility conducting production activities on a daily basis. The contractor gets onboard for repair activity consisting of disassembling equipment previously installed in the platform, assembly of new equipment and posterior welding, and calibration. The contractor and operator conduct an independent analysis of the scope of work and organizational features, identifying specific risks that need to be considered and implementing individual management practices to execute the project. Additionally, it is highly believed that the safety culture and safety management strategies in place are adequate. At the same time, there are some specific problems concerning the project implementation culture coming from the contractor.

5.2. Project and Safety Input

The inputs for project and safety culture are shown in Tables 9 and 10, respectively. The inputs range from 1 to 7. The input of 1 means that the evaluators

consider the presence of the CSF in the organizational and facility's environment as a minimum. In contrast, seven means they consider the presence of the CSF at its maximum.

Table 9. Project Input for Case Study

PF	Critical Success Factor	Please rate the level of presence from 1 to 7.
1	Clear Responsibilities	3
2	Governance and Contracting Structure	3
3	Project Mission (Objectives) - Charter Document	3
4	Project Schedule / Plan	4
5	Competent Personnel	3
6	Reward Criteria	2
7	Ends Orientation	4
8	Risk Tolerance	4
9	Trouble Shooting	5
10	Management Focus	2
11	Member Identity	1
12	Well-Proven Project Management and Communication Tools and Technologies	4
13	Sufficient / Well Allocated Resources	4
14	Unit Integration	3
15	Open-System Focus	5
16	User / Client Involvement	5
17	Competent Project Manager	3
18	Monitoring and Feedback	4
19	Top Management Support	5
20	Control Mechanisms	4
21	Conflict Tolerance	6

Table 10. Safety Input for Case Study

SF	Critical Success Factor	Please rate the level of presence from 1 to 7.
1	Organization Chart Clarity	6
2	Role Clarity	7
3	Role Balance	6
4	Governing Documentation	7
5	Incentive Criteria	6
6	Resource Management	7
7	Competence	6
8	Value Alignment	6
9	Learning From Previous Failures	7
10	Inherent Safety	7
11	ICT Architecture	7
12	Communication	5
13	Cooperation	6
14	Resource Allocation	6
15	Leadership in Safety	6
16	Resource Access	6
17	Commitment to Governing Documentation	6
18	Trust	6
19	Power	7
20	Goal Balance	7

5.3. Project and Safety Output and Analysis

The overall organizational status towards project and safety success is shown in Figure 10. Unfortunately, some level of misalignment is present between cultures due to the situation that safety status can be considered to be in a comfortable road to success,

while the project status is in a discomforting zone in which unexpected situation might occur, jeopardizing the final outcome of the project that is being executed. Therefore, to better analyze the status, a more detailed analysis regarding the pentagon dimensions is needed.

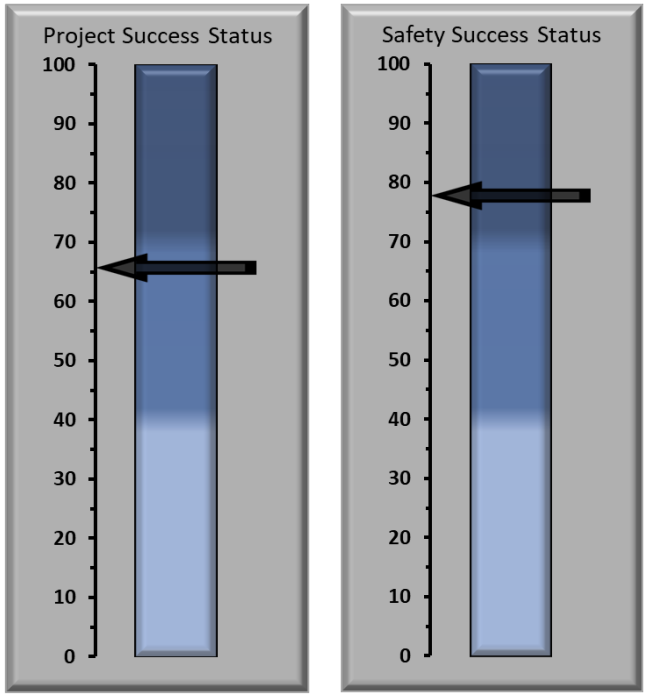

Figure 10. Overall Organizational Status for Project and Safety Success

The dimensional status towards project and safety success for all dimensions of the pentagon model is shown in Figure 11. These results are generated for both the independent and the blended assessment. The independent assessment is carried out without considering project-safety interactions. In contrast, the blended assessment considers the contributions associated to the interactions.

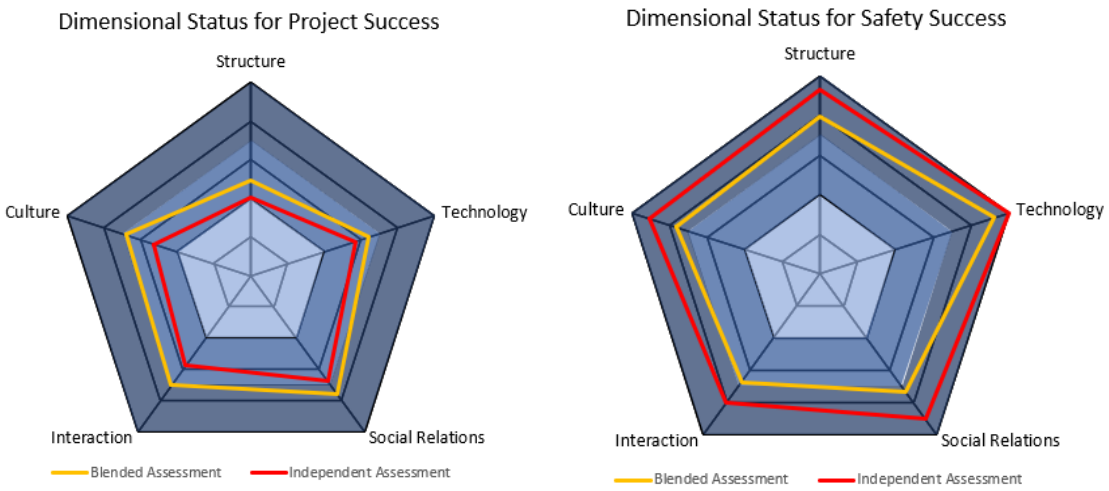

Figure 11. Dimensional Status for Project and Safety Success

It can be seen from the spider diagrams that interactions have a strong influence over the other's culture. The project's status presented an improvement, while safety's status was worsened when considering the interactions. Moreover, it can be understood that focusing improvement efforts on project management culture and strategies is the wisest form to improve the blended results of the organization. The first thought is that it should be done through the structure and technology dimensions, which are the ones that present the lower scores in the project management analysis. Additionally, it can be seen in Figure 12 that these dimensions are the ones that show the most significant misalignment between safety and project.

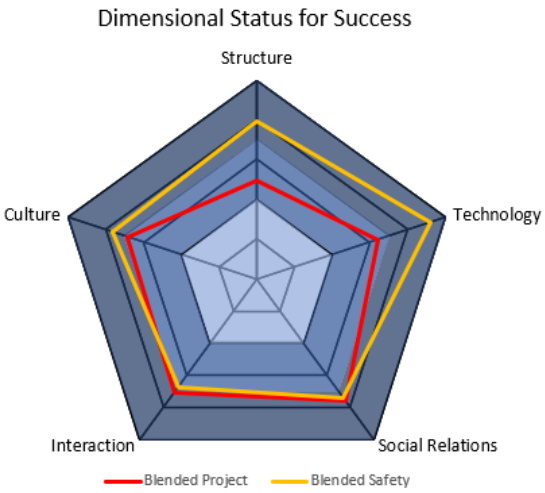

Figure 12. Project and Safety Dimensional Comparison - Initial Assessment

The total possible weighted improvement was calculated and analyzed for each CSF to confirm the actions to be taken. Since the project performance is the one with the most significant problems, the analysis was focused on the project success factors. To calculate the total possible weighted improvement, Equations 8 and 9 were used.

$$RFI = 100 - CSF\ Score \tag{8}$$

$$TWI = RFI * TAI \tag{9}$$

Where RFI is "Room for Improvement," TAI is "Total Aggregated Impact," and TWI is "Total Weighted Improvement." The project success factors were then classified from highest to lowest based on the TWI. Figure 13 shows the results obtained for this analysis. The factors selected for intervention and management were the ones that had a TWI greater than average. These factors were the following:

- Well-Proven PM and Communication Tools and Technologies.
- Reward Criteria.

- Project Mission (Objectives).
- Top Management Support.
- Governance and Contracting Structure.
- Sufficient / Well Allocated Resources.
- Competent Project Manager.
- Clear Responsibilities.

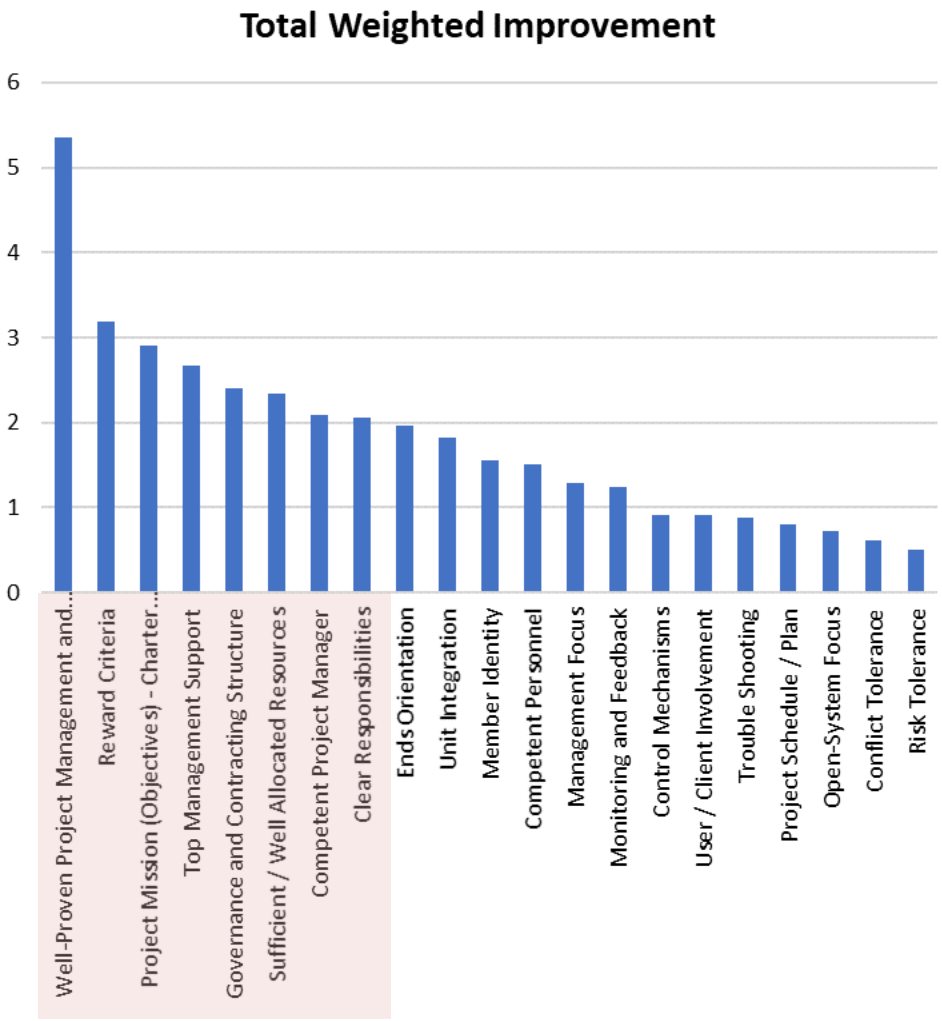

Figure 13. Total Possible Weighted Improvement for Project Factors

5.4. Implementation of Management Strategies and Reassessment

Management strategies were evaluated and implemented to improve the project success factors previously identified. These were done to improve the evaluation of each CSF by 2 points in the 7-point Likert scale that is used in the assessment. The results after the implementation of the recommended strategies are presented next. Figure 14 compares the previous organizational assessment and the organizational assessment conducted after implementing the management strategies. It can be seen that although the strategies were entirely focused on project aspects, the improvement was reflected throughout the overall facility, improving safety performance as well.

Additionally, it can be seen in Figure 15 that misalignment between project and safety performance was reduced. The gaps existing in each dimension are now less meaningful. The significant improvements were associated with the pentagon's structure and technology dimensions. These were the dimensions to which the targeted factors for improvement were related.

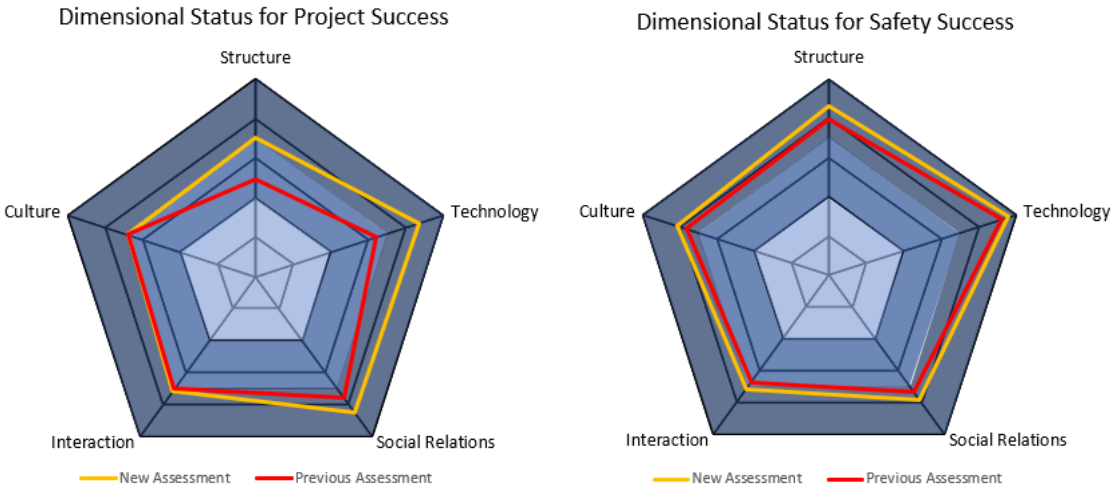

Figure 14. Dimensional Status for Project and Safety Success – Comparison Before and After Management Strategies

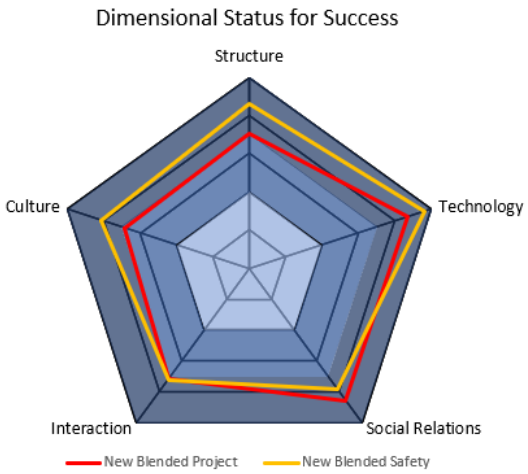

Figure 15. Project and Safety Dimensional Comparison – After Improvement

Finally, it can be seen in Figure 16 that now both project and safety status are on a comfortable road to success, also meaning an improvement in contractor-operator alignment. With these improvements, both project and safety managers and the organization as a whole can now be more confident that successful results will occur.

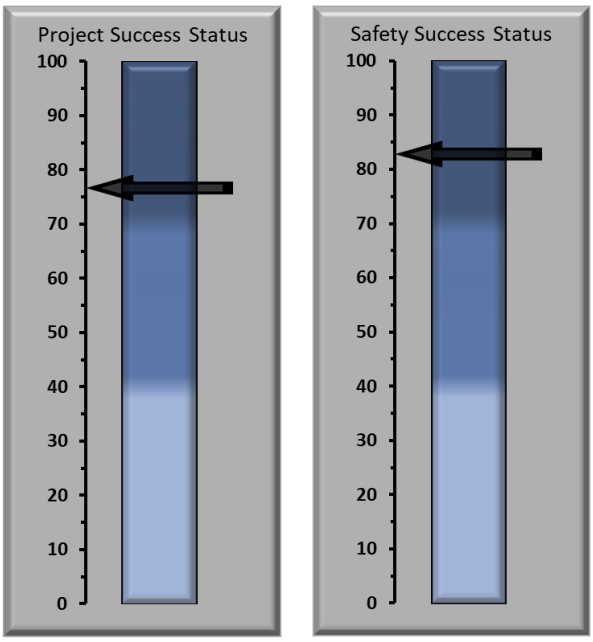

Figure 16. Overall Organizational Status for Project and Safety Success – After Management Strategies

6. CONCLUSIONS AND FUTURE WORK RECOMMENDATIONS

This study fulfilled its objectives of providing a theoretical framework that allows measuring the overall offshore facility culture by considering the interactions between project management and safety cultures. Additionally, detailed management strategies were proposed to improve the critical success factors that drive organizational performance.

Although the theoretical framework is still a work in progress, it has sufficient elements for believing that the proposed approach is the adequate one for evaluating overall facility status. The pentagon model, alongside with the critical success factors, provided sufficient elements for assessing the project organization in a whole way regarding project and safety management practices and behaviors. Considering all the dimensions defining the project and safety status towards success enables the managers to have a broader perspective of all the formal and informal aspects and the tangible and intangible characteristics that affect the execution of the operations. Additionally, identifying that safety and project interactions significantly impact the organizational status proves that a systemic approach in which a holistic analysis is provided is critical for the adequate management of complex organizations.

The theoretical framework developed provides sufficient elements to identify the alignment issues that exist between contractors and operators in the daily operations of the offshore oil and gas facilities. The way results are displayed, alongside the management strategies presented in the theoretical tool, provide a starting point for discussion to

improve the organizational characteristics and identify where the points of failure might be located before starting the execution of a project.

Future work is recommended to validate, through the involvement of industry experts, i.e., managers executing offshore operations, the theoretical approaches and assumptions presented in this study. This expert knowledge is recommended considering that the project and safety interactions were not evaluated by personnel with expertise in offshore operations. Additionally, using specific facility indicators is recommended to assess the actual impact of implementing the developed tool in this study. Finally, as the real indicators are contrasted with the tool, the implementation of Bayesian statistics is recommended to continuously revise the impact of each factor over the facility culture and, hence, provide more accurate assessments and recommendations to the personnel in charge of the facility's operations.

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APPENDIX A

DIMENSIONAL PROPERTIES AND CSF DEFINITIONS

Table 11. Project Dimensional Properties Definitions

Dimensional Property	Definition
Defined Organizational and Project Structure	The degree to which the organizational chart, the governance structure, and the project objectives are clearly defined and specified.
Resource Management	The degree to which project resources such as skilled personnel, equipment, and other requirements (permits) are defined and specified (For example, using adequate project plans).
Incentive Structures	The degree to which reward and recognition systems are structured in a way that promotes employees to meet project objectives while focusing on their professional performance.
Goal Oriented Ways of Working	The degree to which a problem solving, and goal-seeking behavior is fostered.
Value Alignment	The degree to which there is alignment between the personnel's and the management's values so that team's commitment is increased.
Adequate Project Tools	The degree to which tools, technologies, and resources are allocated in time and according to the project needs.
The Four Cs	The degree to which cooperation, collaboration, communication, and coordination are fostered within the project personnel to reach project objectives.
Team Management	The degree to which leadership and performance evaluations are adequately used to improve team interaction and personnel's performance.
Committed and Trusted Social Capital	The degree to which there is a committed and trusted team executing the project and adequate support from top management regarding all decision-making processes.
Behavioral Agreement	The degree to which there is a common agreement between the organization and the personnel to address conflicts and promote project success.

Table 12. Project Success Factors Definitions

Critical Success Factors	Definition
Unit Integration	The degree to which units within the organization are encouraged to operate in a coordinated or interdependent manner. Team promotion and coordination is required for successful project implementation.
Clear Responsibilities	The degree to which responsibilities are clearly defined and understood by all the employees. What to do, what to communicate, which reports to be made, etc.
Reward Criteria	The degree to which rewards such as promotion and salary increments are allocated according to employee performance rather than seniority, favoritism, or other non-performance factors.
Project Mission	The degree to which there is clarity of goals and general directions. What is going to be developed, what the project capabilities are, why the project is needed and how it will benefit those who use it.
Project Schedule / Plan	The degree to which time schedules, milestones, manpower, and equipment requirements are specified. The schedule should also include a satisfactory measurement system as a way of judging actual performance against budget and time allowances.
Ends Orientation	The degree to which management focuses more on outcomes rather than on techniques and processes used to achieve those results.
Governance and Contracting Structure	To what extent there is clarity in the details of the governance and contracting structure of the project. Refers to the structure that defines how the relations between the different parties involved will be managed. Includes how decisions will be made and how the procedures will be executed.
Risk Tolerance	The degree to which employees are encouraged to be aggressive, innovative, and risk-seeking when solving problems.
Management Focus	The degree to which management decisions consider the effect of outcomes on people within the organization.
Top Management Support	The degree to which top management is willing to provide the necessary resources (financial, manpower, time) and authority/power for project success. It also includes confidence in their support in the event of a crisis.
Control Mechanisms	To what extent there is a good balance between formal and informal rules to oversee and control employee behavior.
Well-Proven Project Management and Communication Tools and Technologies	The degree to which reliable and appropriate project management and communication tools and technologies are implemented for project controls. An appropriate network and necessary data to all key actors in the project implementation needs to be provided, in order to create an atmosphere for successful project implementation.
Sufficient / Well Allocated Resources	The degree to which the necessary resources (equipment, materials, manpower and technologies) are allocated on time and accordingly to the required quantities and technical specifications of the project.

Table 12. Continued

Critical Success Factors	Definition
Trouble Shooting	The degree to which team members have the ability to be on a lookout for problems. It also refers to the availability of contingency plans, systems and procedures that are in place in order to handle unexpected crises and deviations from plan.
Conflict Tolerance	The degree to which employees are encouraged to air conflicts and criticisms informally and openly.
Member Identity	The degree to which employees identify with the organization. Being identified with the organization will increase the employees' commitment to the project results.
Open-System Focus	The degree to which the organization monitors and responds to changes in the external environment.
User / Client Involvement	The degree to which communication, consultation, and active listening is performed with the user / client. Because a project is intended for the client's benefit, close communication and frequent consultation with the client is imperative to make sure the effort remains in line with his needs.
Competent Project Manager	The degree to which the project manager has adequate technical and leadership skills to influence, motivate, and enable the project team to contribute towards the effectiveness and success of the project they are working on.
Monitoring and Feedback	The degree to which there is timely provision of comprehensive control information at each stage in the implementation process. Refers not only to the process by which key personnel receive feedback on how the project is comparing to initial projections but also to monitoring performance of members of the project team.
Competent Personnel	The degree to which there is adequate recruitment, assignment, and training of the necessary personnel for the project team. Project team should be staffed by personnel with the required skills and commitment to perform their functions.

Table 13. Safety Dimensional Properties Definitions

Dimensional Property	Definition
Role Clarity and Balance	The degree to which roles and responsibilities are clearly defined e.g., in governing documentation, is understood, and there is a good balance between control, demand and support in roles and responsibilities.
Incentive Criteria	To what extent the project organization is structured with incentives to obtain safety performance. This includes clear expectations, support by managers/ co-workers, and rewards.
Resource Management	To what extent the project organization implements recruitment and training of personnel to ensure safety performance.
Competence	To what extent the personnel in the project organization have sufficient knowledge and skills to perform safety critical operations correctly. This includes learning from previous failures.
Values (actual)	To what extent there is correspondence between espoused (stated) values and enacted (actually done) values.
Inherent Safety	To what extent tools, machinery and safety critical ICT systems are designed and maintained to contribute to hazard prevention/ risk reduction and are robust against intentional and unintentional failures/events.
Cooperation	To what extent safety critical information, e.g., operational procedures, is clear and understandable and there is good collaboration/ confidence/ teamwork within the project organization, with stakeholders and between the offshore/onshore organizations.
Leadership in Safety	To what extent resources are sufficient and well distributed to maintain safety critical issues and the leaders balance the focus on the tasks that need to be performed and the well-being of the team members, in order to meet safety critical goals.
Commitment to Governing Documentation	To what extent personnel carry out safety critical work tasks in compliance with governing documentation and have access to relevant competence and corrections when needed. This includes systems for management of change (MOC).
Goal Balance	To what extent there is a good balance between safety performance and other goals.

Table 14. Safety Success Factors Definitions

Critical Success Factors	Definition
Organization Chart Clarity	The degree of clarity on how roles and responsibilities are divided within the departments/units.
Role Clarity	The degree of which roles and responsibilities are clearly defined and understood.
Role Balance	To what extent there is a good balance between control, demand and support in roles and responsibilities.
Governing Documentation	To what extent the governing documentation related to safety critical operations is accurate, accessible, and comprehensible.
Incentive Criteria	To what extent the project organization is structured with incentives to obtain safety performance. This includes clear expectations, support by managers/ co-workers, and rewards.
Resource Management	To what extent the project organization structures recruitment and training of personnel to ensure safety performance.
Competence	To what extent the personnel in the project organization have sufficient knowledge and skills to perform safety critical operations correctly.
Value Alignment	To what extent there is correspondence between espoused (stated) values and enacted (actually done) values.
Learning From Previous Failures	To what extent the project team is able to learn, i.e., change practices, based on previous failures and events in relation to safety critical operations.
Inherent Safety	To what extent tools and machinery are designed to contribute to hazard prevention and risk reduction.
ICT Architecture	To what extent safety critical ICT systems are robust against intentional and unintentional failures/events.
Communication	To what extent safety critical information is clear and understandable.
Cooperation	To what extent there is good collaboration/ teamwork within the project organization, with stakeholders and between the offshore/onshore organizations.
Resource Allocation	To what extent resources are sufficient and well distributed to maintain safety critical issues.
Leadership in Safety	To what extent the leader balance the focus on the tasks that need to be performed and the well-being of the team members, in order to meet safety critical goals.
Resource Access	To what extent team members have access to relevant competence and corrections when performing safety critical tasks.
Commitment to Governing Documentation	To what extent personnel carry out work tasks in compliance with governing documentation.
Trust	To what extent the team members and leaders have confidence in each other.
Power	To what extent power is distributed among different parties in the organization to enable safety critical tasks to be carried out in a non-hazardous way.
Goal Balance	To what extent there is a good balance between safety performance and other goals.

APPENDIX B

PROJECT AND SAFETY CSF INTERACTIONS

Table 15. Project to Safety Factors Influence Matrix

		SF1	SF2	SF3	SF4	SF5
		Organization Chart Clarity	Role Clarity	Role Balance	Governing Documentation	Incentive Criteria
PF1	Clear Responsibilities	+	+			
PF2	Governance and Contracting Structure	+	+	+	+	+
PF3	Project Mission					+
PF4	Project Schedule / Plan					
PF5	Competent Personnel					
PF6	Reward Criteria					+
PF7	Ends Orientation					
PF8	Risk Tolerance					
PF9	Trouble Shooting					
PF10	Management Focus					
PF11	Member Identity					
PF12	Well-Proven PM and Communication Tools and Technologies				+	
PF13	Sufficient / Well Allocated Resources					
PF14	Unit Integration					
PF15	Open System Focus					
PF16	User / Client Involvement					+
PF17	Competent Project Manager			+		+
PF18	Monitoring and Feedback					
PF19	Top Management Support				+	+
PF20	Control Mechanisms			+		+
PF21	Conflict Tolerance					

Table 15. Continued

		SF6	SF7	SF8	SF9	SF10
		Resource Management	Competence	Value Alignment	Learning From Previous Failures	Inherent Safety
PF1	Clear Responsibilities		+			
PF2	Governance and Contracting Structure	+			+	
PF3	Project Mission	+				
PF4	Project Schedule / Plan					
PF5	Competent Personnel	+	+			
PF6	Reward Criteria				-	
PF7	Ends Orientation			-	-	-
PF8	Risk Tolerance			+		
PF9	Trouble Shooting					
PF10	Management Focus	+				
PF11	Member Identity				+	
PF12	Well-Proven PM and Communication Tools and Technologies		+		+	
PF13	Sufficient / Well Allocated Resources	+				+
PF14	Unit Integration					
PF15	Open System Focus	+			+	
PF16	User / Client Involvement				+	
PF17	Competent Project Manager	+	+		+	
PF18	Monitoring and Feedback	+			+	
PF19	Top Management Support	+		+	+	+
PF20	Control Mechanisms					
PF21	Conflict Tolerance		+		+	

Table 15. Continued

		SF11	SF12	SF13	SF14	SF15
		ICT Architecture	Communication	Cooperation	Resource Allocation	Leadership in Safety
PF1	Clear Responsibilities			+		
PF2	Governance and Contracting Structure				+	
PF3	Project Mission				+	+
PF4	Project Schedule / Plan				+	
PF5	Competent Personnel		+	+		
PF6	Reward Criteria					+
PF7	Ends Orientation				-	-
PF8	Risk Tolerance					
PF9	Trouble Shooting			+	+	
PF10	Management Focus				+	+
PF11	Member Identity			+		+
PF12	Well-Proven PM and Communication Tools and Technologies		+	+	+	
PF13	Sufficient / Well Allocated Resources				+	
PF14	Unit Integration			+		+
PF15	Open System Focus			+	+	
PF16	User / Client Involvement		+	+	+	
PF17	Competent Project Manager		+	+	+	+
PF18	Monitoring and Feedback		+	+	+	+
PF19	Top Management Support				+	+
PF20	Control Mechanisms					
PF21	Conflict Tolerance		+	+		

Table 15. Continued

		SF16	SF17	SF18	SF19	SF20
		Resource Access	Commitment to Governing Documentation	Trust	Power	Goal Balance
PF1	Clear Responsibilities		+			
PF2	Governance and Contracting Structure		+		+	+
PF3	Project Mission					+
PF4	Project Schedule / Plan					+
PF5	Competent Personnel	+		+		
PF6	Reward Criteria			+		+
PF7	Ends Orientation		-	-	-	-
PF8	Risk Tolerance		-			
PF9	Trouble Shooting	+		+		+
PF10	Management Focus		+	+		
PF11	Member Identity	+		+		
PF12	Well-Proven PM and Communication Tools and Technologies	+				
PF13	Sufficient / Well Allocated Resources	+				+
PF14	Unit Integration	+				
PF15	Open System Focus					+
PF16	User / Client Involvement			+		+
PF17	Competent Project Manager	+		+		+
PF18	Monitoring and Feedback	+		+		+
PF19	Top Management Support			+		+
PF20	Control Mechanisms		+			+
PF21	Conflict Tolerance	+		+		

Table 16. Safety to Project Factors Influence Matrix

		PF1	PF2	PF3	PF4	PF5
		Clear Responsibilities	Governance and Contracting Structure	Project Mission	Project Schedule / Plan	Competent Personnel
SF1	Organization Chart Clarity	+	+			
SF2	Role Clarity	+	+			+
SF3	Role Balance		+			
SF4	Governing Documentation	+	+			
SF5	Incentive Criteria					
SF6	Resource Management					+
SF7	Competence					+
SF8	Value Alignment					
SF9	Learning From Previous Failures					+
SF10	Inherent Safety					
SF11	ICT Architecture					
SF12	Communication					
SF13	Cooperation					
SF14	Resource Allocation					+
SF15	Leadership in Safety					
SF16	Resource Access					
SF17	Commitment to Governing Documentation					
SF18	Trust					
SF19	Power					
SF20	Goal Balance					

Table 16. Continued

		PF6	PF7	PF8	PF9	PF10
		Reward Criteria	Ends Orientation	Risk Tolerance	Trouble Shooting	Management Focus
SF1	Organization Chart Clarity					
SF2	Role Clarity				+	
SF3	Role Balance			-		
SF4	Governing Documentation			-		
SF5	Incentive Criteria	+	+	-	+	+
SF6	Resource Management					
SF7	Competence				+	
SF8	Value Alignment		+	-	+	+
SF9	Learning From Previous Failures		-	-	+	
SF10	Inherent Safety					
SF11	ICT Architecture					
SF12	Communication				+	
SF13	Cooperation				+	+
SF14	Resource Allocation			-	+	
SF15	Leadership in Safety	+	-	-	+	+
SF16	Resource Access			+		
SF17	Commitment to Governing Documentation		-	+		
SF18	Trust					
SF19	Power		-			
SF20	Goal Balance		-	-		+

Table 16. Continued

		PF11	PF12	PF13	PF14	PF15
		Member Identity	Well-Proven PM and Communication Tools and Technologies	Sufficient / Well Allocated Resources	Unit Integration	Open System Focus
SF1	Organization Chart Clarity					
SF2	Role Clarity				+	
SF3	Role Balance	+			+	
SF4	Governing Documentation					
SF5	Incentive Criteria	+		+	+	
SF6	Resource Management			+		
SF7	Competence					
SF8	Value Alignment	+				
SF9	Learning From Previous Failures					+
SF10	Inherent Safety			+		
SF11	ICT Architecture			+		
SF12	Communication					
SF13	Cooperation	+			+	
SF14	Resource Allocation			+		
SF15	Leadership in Safety	+		+	+	+
SF16	Resource Access				+	
SF17	Commitment to Governing Documentation					
SF18	Trust	+				
SF19	Power					
SF20	Goal Balance					

Table 16. Continued

		PF16	PF17	PF18	PF19	PF20	PF21
		User / Client Involvement	Competent Project Manager	Monitoring and Feedback	Top Management Support	Control Mechanisms	Conflict Tolerance
SF1	Organization Chart Clarity						
SF2	Role Clarity	+		+			
SF3	Role Balance					+	
SF4	Governing Documentation			+			
SF5	Incentive Criteria	+		+		+	
SF6	Resource Management	+	+				+
SF7	Competence	+	+	+		+	+
SF8	Value Alignment					+	+
SF9	Learning From Previous Failures	+		+	+		
SF10	Inherent Safety						
SF11	ICT Architecture						
SF12	Communication	+		+		+	
SF13	Cooperation	+		+		+	+
SF14	Resource Allocation						
SF15	Leadership in Safety	+					+
SF16	Resource Access					+	
SF17	Commitment to Governing Documentation					+	
SF18	Trust	+				+	+
SF19	Power	+				+	+
SF20	Goal Balance					-	

APPENDIX C

PROJECT AND SAFETY WEIGHTS

Table 17. Weights of Project Links

Dimension	DP Weight	Dimensional Property	CSF Weight	Critical Success Factor
Structure	63.33%	Defined Organizational and Project Structure	33.33%	Clear Responsibilities
			33.33%	Governance and Contracting Structure
			33.33%	Project Mission (Objectives)
	10.62%	Resource Management	75.00%	Project Schedule / Plan
			25.00%	Competent Personnel
	26.05%	Incentive Structures	100.00%	Reward Criteria
Culture	75.00%	Goal Oriented Ways of Working	42.86%	Ends Orientation
			14.29%	Risk Tolerance
			42.86%	Trouble Shooting
	25.00%	Value Alignment	50.00%	Management Focus
			50.00%	Member Identity
Technology	100.00%	Adequate Project Tools	50.00%	Well-Proven PM and Communication Tools and Technologies
			50.00%	Sufficient / Well Allocated Resources
Interaction	75.00%	The Four Cs	42.86%	Unit Integration
			14.29%	Open-System Focus
			42.86%	User / Client Involvement
	25.00%	Team Management	25.00%	Competent Project Manager
			75.00%	Monitoring and Feedback
Social Relations	50.00%	Committed and Trusted Social Capital	75.00%	Top Management Support
			25.00%	Competent Personnel
	50.00%	Behavioral Agreement	50.00%	Control Mechanisms
			50.00%	Conflict Tolerance

Table 18. Weights of Safety Links

Dimension	DP Weight	Dimension Property	CSF Weight	Critical Success Factor
Structure	60.00%	Role Clarity and Balance	6.87%	Organization Chart Clarity
			15.35%	Role Clarity
			38.89%	Role Balance
			38.89%	Governing Documentation
	20.00%	Incentive Criteria	100.00%	Incentive Criteria
	20.00%	Resource Management	100.00%	Resource Management
Culture	33.33%	Competence	100.00%	Competence
	66.67%	Values (Actual)	50.00%	Value Alignment
			50.00%	Learning From Previous Failures
Technology	100.00%	Inherent Safety	83.33%	Inherent Safety
			16.67%	ICT Architecture
Interaction	75.00%	Cooperation	50.00%	Communication
			50.00%	Cooperation
	25.00%	Leadership in Safety	50.00%	Resource Allocation
			50.00%	Leadership in Safety
Social Relations	66.67%	Commitment to Governing Documentation	40.55%	Resource Access
			47.96%	Commitment to Governing Documentation
			11.50%	Trust
	33.33%	Goal Balance	50.00%	Power
			50.00%	Goal Balance

Table 19. Weights of Links for Combined Project Evaluation

Critical Success Factor	Contr Weight	Lower-Level Contributor
Clear Responsibilities	75.00%	Clear Responsibilities
	8.33%	Organization Chart Clarity
	8.33%	Role Clarity
	8.33%	Governing Documentation
Governance and Contracting Structure	69.23%	Governance and Contracting Structure
	7.69%	Organization Chart Clarity
	7.69%	Role Clarity
	7.69%	Role Balance
	7.69%	Governing Documentation
Project Mission (Objectives) - Charter Document	100.00%	Project Mission (Objectives) - Charter Document
Project Schedule / Plan	100.00%	Project Schedule / Plan
Competent Personnel	64.29%	Competent Personnel
	7.14%	Role Clarity
	7.14%	Resource Management
	7.14%	Competence
	7.14%	Learning From Previous Failures
	7.14%	Resource Allocation
Reward Criteria	81.82%	Reward Criteria
	9.09%	Incentive Criteria
	9.09%	Leadership in Safety
Ends Orientation	56.25%	Ends Orientation
	6.25%	Incentive Criteria
	6.25%	Value Alignment
	6.25%	Learning From Previous Failures
	6.25%	Leadership in Safety
	6.25%	Commitment to Governing Documentation
	6.25%	Power
	6.25%	Goal Balance

Table 19. Continued

Critical Success Factor	Contr Weight	Lower-Level Contributor
Risk Tolerance	47.37%	Risk Tolerance
	5.26%	Role Balance
	5.26%	Governing Documentation
	5.26%	Incentive Criteria
	5.26%	Value Alignment
	5.26%	Learning From Previous Failures
	5.26%	Resource Allocation
	5.26%	Leadership in Safety
	5.26%	Resource Access
	5.26%	Commitment to Governing Documentation
	5.26%	Goal Balance
Trouble Shooting	50.00%	Trouble Shooting
	5.56%	Role Clarity
	5.56%	Incentive Criteria
	5.56%	Competence
	5.56%	Value Alignment
	5.56%	Learning From Previous Failures
	5.56%	Communication
	5.56%	Cooperation
	5.56%	Resource Allocation
	5.56%	Leadership in Safety
Management Focus	64.29%	Management Focus
	7.14%	Incentive Criteria
	7.14%	Value Alignment
	7.14%	Cooperation
	7.14%	Leadership in Safety
	7.14%	Goal Balance
Member Identity	60.00%	Member Identity
	6.67%	Role Balance
	6.67%	Incentive Criteria
	6.67%	Value Alignment
	6.67%	Cooperation
	6.67%	Leadership in Safety
	6.67%	Trust
Well-Proven Project Management and Communication Tools and Technologies	100.00%	Well-Proven Project Management and Communication Tools and Technologies

Table 19. Continued

Critical Success Factor	Contr Weight	Lower-Level Contributor
Sufficient / Well Allocated Resources	60.00%	Sufficient / Well Allocated Resources
	6.67%	Incentive Criteria
	6.67%	Resource Management
	6.67%	Inherent Safety
	6.67%	ICT Architecture
	6.67%	Resource Allocation
	6.67%	Leadership in Safety
Unit Integration	60.00%	Unit Integration
	6.67%	Cooperation
	6.67%	Leadership in Safety
	6.67%	Resource Access
	6.67%	Role Clarity
	6.67%	Role Balance
	6.67%	Incentive Criteria
Open-System Focus	81.82%	Open-System Focus
	9.09%	Learning From Previous Failures
	9.09%	Leadership in Safety
User / Client Involvement	47.37%	User / Client Involvement
	5.26%	Role Clarity
	5.26%	Incentive Criteria
	5.26%	Resource Management
	5.26%	Competence
	5.26%	Learning From Previous Failures
	5.26%	Communication
	5.26%	Cooperation
	5.26%	Leadership in Safety
	5.26%	Trust
	5.26%	Power
Monitoring and Feedback	56.25%	Monitoring and Feedback
	6.25%	Role Clarity
	6.25%	Governing Documentation
	6.25%	Incentive Criteria
	6.25%	Competence
	6.25%	Learning From Previous Failures
	6.25%	Communication
	6.25%	Cooperation

Table 19. Continued

Critical Success Factor	Contr Weight	Lower-Level Contributor
Top Management Support	90.00%	Top Management Support
	10.00%	Learning From Previous Failures
Competent Personnel	64.29%	Competent Personnel
	7.14%	Role Clarity
	7.14%	Resource Management
	7.14%	Competence
	7.14%	Learning From Previous Failures
	7.14%	Resource Allocation
Control Mechanisms	45.00%	Control Mechanisms
	5.00%	Role Balance
	5.00%	Incentive Criteria
	5.00%	Competence
	5.00%	Value Alignment
	5.00%	Communication
	5.00%	Cooperation
	5.00%	Resource Access
	5.00%	Commitment to Governing Documentation
	5.00%	Trust
	5.00%	Power
	5.00%	Goal Balance
Conflict Tolerance	56.25%	Conflict Tolerance
	6.25%	Resource Management
	6.25%	Competence
	6.25%	Value Alignment
	6.25%	Cooperation
	6.25%	Leadership in Safety
	6.25%	Trust
	6.25%	Power
Competent Project Manager	81.82%	Competent Project Manager
	9.09%	Resource Management
	9.09%	Competence

Table 20. Weights of Links for Combined Safety Evaluation

Critical Success Factor	Contr Weight	2nd Stage Contributor
Organization Chart Clarity	81.82%	Organization Chart Clarity
	9.09%	Clear Responsibilities
	9.09%	Governance and Contracting Structure
Role Clarity	81.82%	Role Clarity
	9.09%	Clear Responsibilities
	9.09%	Governance and Contracting Structure
Role Balance	75.00%	Role Balance
	8.33%	Governance and Contracting Structure
	8.33%	Control Mechanisms
	8.33%	Competent Project Manager
Governing Documentation	75.00%	Governing Documentation
	8.33%	Governance and Contracting Structure
	8.33%	Top Management Support
	8.33%	Well-Proven Project Management and Communication Tools and Technologies
Incentive Criteria	56.25%	Incentive Criteria
	6.25%	Reward Criteria
	6.25%	Project Mission (Objectives) - Charter Document
	6.25%	Governance and Contracting Structure
	6.25%	Top Management Support
	6.25%	Control Mechanisms
	6.25%	User / Client Involvement
	6.25%	Competent Project Manager
Resource Management	50.00%	Resource Management
	5.56%	Project Mission (Objectives) - Charter Document
	5.56%	Governance and Contracting Structure
	5.56%	Management Focus
	5.56%	Top Management Support
	5.56%	Sufficient / Well Allocated Resources
	5.56%	Open-System Focus
	5.56%	Competent Project Manager
	5.56%	Monitoring and Feedback
	5.56%	Competent Personnel

Table 20. Continued

Critical Success Factor	Contr Weight	2nd Stage Contributor
Competence	64.29%	Competence
	7.14%	Clear Responsibilities
	7.14%	Well-Proven Project Management and communication Tools and Technologies
	7.14%	Conflict Tolerance
	7.14%	Competent Project Manager
	7.14%	Competent Personnel
Value Alignment	75.00%	Value Alignment
	8.33%	Ends Orientation
	8.33%	Risk Tolerance
	8.33%	Top Management Support
Learning From Previous Failures	45.00%	Learning From Previous Failures
	5.00%	Reward Criteria
	5.00%	Ends Orientation
	5.00%	Governance and Contracting Structure
	5.00%	Top Management Support
	5.00%	Well-Proven Project Management and communication Tools and Technologies
	5.00%	Conflict Tolerance
	5.00%	Member Identity
	5.00%	Open-System Focus
	5.00%	User / Client Involvement
	5.00%	Competent Project Manager
	5.00%	Monitoring and Feedback
Inherent Safety	75.00%	Inherent Safety
	8.33%	Ends Orientation
	8.33%	Top Management Support
	8.33%	Sufficient / Well Allocated Resources
ICT Architecture	100.00%	ICT Architecture
Communication	60.00%	Communication
	6.67%	Well-Proven Project Management and communication Tools and Technologies
	6.67%	Conflict Tolerance
	6.67%	User / Client Involvement
	6.67%	Competent Project Manager
	6.67%	Monitoring and Feedback
	6.67%	Competent Personnel

Table 20. Continued

Critical Success Factor	Contr Weight	2nd Stage Contributor
Cooperation	45.00%	Cooperation
	5.00%	Unit Integration
	5.00%	Clear Responsibilities
	5.00%	Well-Proven Project Management and communication Tools and Technologies
	5.00%	Trouble Shooting
	5.00%	Conflict Tolerance
	5.00%	Member Identity
	5.00%	Open-System Focus
	5.00%	User / Client Involvement
	5.00%	Competent Project Manager
	5.00%	Monitoring and Feedback
	5.00%	Competent Personnel
Resource Allocation	40.91%	Resource Allocation
	4.55%	Project Mission (Objectives) - Charter Document
	4.55%	Project Schedule / Plan
	4.55%	Ends Orientation
	4.55%	Governance and Contracting Structure
	4.55%	Management Focus
	4.55%	Top Management Support
	4.55%	Well-Proven Project Management and communication Tools and Technologies
	4.55%	Sufficient / Well Allocated Resources
	4.55%	Trouble Shooting
	4.55%	Open-System Focus
	4.55%	User / Client Involvement
	4.55%	Competent Project Manager
	4.55%	Monitoring and Feedback

Table 20. Continued

Critical Success Factor	Contr Weight	2nd Stage Contributor
Leadership in Safety	50.00%	Leadership in Safety
	5.56%	Unit Integration
	5.56%	Reward Criteria
	5.56%	Project Mission (Objectives) - Charter Document
	5.56%	Ends Orientation
	5.56%	Management Focus
	5.56%	Top Management Support
	5.56%	Member Identity
	5.56%	Competent Project Manager
	5.56%	Monitoring and Feedback
Resource Access	50.00%	Resource Access
	5.56%	Unit Integration
	5.56%	Well-Proven Project Management and communication Tools and Technologies
	5.56%	Sufficient / Well Allocated Resources
	5.56%	Trouble Shooting
	5.56%	Conflict Tolerance
	5.56%	Member Identity
	5.56%	Competent Project Manager
	5.56%	Monitoring and Feedback
	5.56%	Competent Personnel
Commitment to Governing Documentation	60.00%	Commitment to Governing Documentation
	6.67%	Clear Responsibilities
	6.67%	Ends Orientation
	6.67%	Governance and Contracting Structure
	6.67%	Risk Tolerance
	6.67%	Management Focus
	6.67%	Control Mechanisms

Table 20. Continued

Critical Success Factor	Contr Weight	2nd Stage Contributor
Trust	45.00%	Trust
	5.00%	Reward Criteria
	5.00%	Ends Orientation
	5.00%	Management Focus
	5.00%	Top Management Support
	5.00%	Trouble Shooting
	5.00%	Conflict Tolerance
	5.00%	Member Identity
	5.00%	User / Client Involvement
	5.00%	Competent Project Manager
	5.00%	Monitoring and Feedback
	5.00%	Competent Personnel
Power	81.82%	Power
	9.09%	Ends Orientation
	9.09%	Governance and Contracting Structure
Goal Balance	40.91%	Goal Balance
	4.55%	Reward Criteria
	4.55%	Project Mission (Objectives) - Charter Document
	4.55%	Project Schedule / Plan
	4.55%	Ends Orientation
	4.55%	Governance and Contracting Structure
	4.55%	Top Management Support
	4.55%	Control Mechanisms
	4.55%	Sufficient / Well Allocated Resources
	4.55%	Trouble Shooting
	4.55%	Open-System Focus
	4.55%	User / Client Involvement
	4.55%	Competent Project Manager
	4.55%	Monitoring and Feedback

APPENDIX D

PROJECT AND SAFETY MANAGEMENT STRATEGIES

Table 21. Management Assessments for Project Success Factors

CSF	Descriptor	Management Statements
Clear Responsibilities	Role Definition and Clarity	Job descriptions for each team member role have been specified, written, and distributed.
		The division between operational and project responsibilities is clearly defined.
		Differences between the different roles in the organization are clearly specified.
	Role Understanding	The personnel understand their specific tasks for the project.
		Each team member knows exactly what he/she is responsible for in the project implementation.
		Personnel know what to do in an emergency situation
		Personnel know who in the organization to report to.
		Each team member has a clear understanding of his/her role in the team.
Governance and Contracting Structure	Stakeholder's Level of Involvement	All relevant stakeholders are disciplined to deliver according to plan.
		External stakeholders' expectations are clearly defined.
	Organizational Structure	Management (owner) does not interfere with decision making procedures.
		Client knows who to contact in case of questions or misunderstandings at all phases of the project.
		Project teams are supported by the structure of the organizations.
		The lines of authority and communication are well defined on the project team.
		Formal relations between project team members are clearly defined.
	Organizational Procedures	It is easy to find relevant governing documentation
		The personnel have good knowledge of HSE related procedures
Project Mission (Objectives) - Charter Document	Goals Definition	The project goals can all be achieved. They are reasonable.
		The project goals have been well defined, in terms of quantity and quality expected for its achievement.
	Goals Acceptance	The project goals have been explained to all personnel affected by the project.
		The personnel on the project team are committed to the project's success.
	Goals Accuracy	When the project goals are achieved, the results will benefit the organization.
		The project goals reflect the urgency level / importance of the project.
		The project goals are in line with the general goals of the organization.
		Organizational goals supersede the personal agendas of the client.

Table 21. Continued

CSF	Descriptor	Management Statements
Project Schedule / Plan	Resource & Work Allocation Plan	There is a detailed plan (including time schedules, milestones, manpower requirements, equipment) for the completion of the project.
		The budget and schedule specifications have been well defined.
	Commitment to Plan	Personnel is disciplined and committed to deliver according to plan.
		The project cannot deviate from the phases according to the project life cycle.
	Budget Constraints	There is a detailed budget for the project that is followed.
		Budgets are not exceeded.
Competent Personnel	Training	Adequate technical and/or managerial training (and time for training) is available for members of the project team.
		Emergency preparedness training is good
		The training for new technologies is done accordingly to the complexity in order to ensure project success.
		The project team has the adequate training and know the different procedures required for the different tasks.
	Recruitment	The technical skills required for the different activities are considered when recruiting the personnel.
		The technical skills required are considered when selecting the team members for the project.
		Team members are carefully selected for each project based on their related experience to the project goals.
	Technical Knowledge and Skills	Personnel have the necessary skills to do the job in a safe way.
		Personnel have adequate knowledge of new technology to reduce accident risk.
		The project team process in an adequate manner the information obtained from the PM tools.
		The project team includes personnel with adequate technical and managerial skills.
		The project team has the technical capabilities required to follow the project's plan and schedule.
		The engineers and other technical people are capable.
Reward Criteria	Incentive Distribution	Rewards and recognition are used to increase motivation in projects.
		Rewards are based on the performance of the project team
		The salaries are not only based on the hierarchical structure of the organization. Performance is considered.
		There is room for professional growth (promotions) inside the organization.
	Performance Evaluation	Individual performance is evaluated according to the project goals.
		The results of the project influence individual performance appraisal.
Ends Orientation	Results Driven	It does not matter what means are used, as long as the results are achieved.
		Teams have structural flexibility to perform their tasks.
		The project process is focused on results.

Table 21. Continued

CSF	Descriptor	Management Statements
Risk Tolerance	Safety Requirements	Safety requirements are considered along with project benefits when developing innovative solutions to problems.
		Personnel do not break safety rules to get the job done quickly.
		Personnel stop working if they think it can be dangerous for them or others to continue.
		The work permit system (AT) is always complied with.
	Project Manager's Style	The project manager's style is adaptive to the different project phases.
		Calculated risk taking is encouraged when analyzing alternative approaches for achieving results.
		Managers encourage innovation and creativity among the project team members.
Trouble Shooting	Risk Assessment	Project team is aware of project "problem areas".
		Risky work operations are always carefully reviewed before they begin.
		Feasibility studies are done before implementing the project.
	Problem Solving	Project team members are encouraged to take quick action on problems on their own initiative.
		The project team includes personnel with adequate technical and managerial skills to manage the required tools.
	Risk Monitoring	Risk is monitored on a continuous basis.
		Uncertainty is dealt with through open communication.
		Project team holds "brainstorming" sessions to determine where problems are most likely to occur.
Management Focus	Employee Welfare	Managers recognize the importance of the employee's personal welfare when making decisions.
		Employee's personal situation is considered when assigning tasks to the employees.
	Decisions by Committee	Employees have representatives when the organization makes decisions that affect them.
		Important decisions concerning the project team are taken by a committee made up by all stakeholders.
		Business is conducted in an ethical manner.
Member Identity	Organization's Values and Norms	There is a strong sense of belonging between the project team members.
		The culture of the stakeholders define the way in which they are going to relate.
		Even though not everyone speaks the same language, the agreed culture avoids the arising of dangerous situations.
	Team Support	Teams receive support from other teams and team members when necessary.
		Team members look out for each other's interest.

Table 21. Continued

CSF	Descriptor	Management Statements
Well-Proven Project Management and Communication Tools and Technologies	Progress Reports	The information systems utilized provide timely reports of the selected performance measures.
		The tools implemented are adequately used and provide timely and reliable information to the project team.
	Interface Management Needs	The format of communication between the involved parties is determined by the size of the project team.
		The project management tools are selected accordingly to meet the needs of the activities that are going to be monitored.
	Information Flow	There exist well-defined channels for feedback from clients, upper management, members of other groups, and project team members when project implementation begins.
		The tools that are used by the project team provide adequate information flow and accurate data.
Sufficient / Well Allocated Resources	Amount of Resources	Managers understand the amount of resources (money, time, manpower, equipment, etc.) required to implement the project on time.
		Managers are responsive to the requests for additional resources in case they are needed.
		There is enough manpower to complete the project.
	Quality of Resources	The equipment needed to work safely is readily available.
		The technology that is being implemented works well.
		Adequate maintenance is provided to equipment to increase safety.
	Resources Needs	The appropriate technology (equipment, materials) has been selected for project success.
		The technical needs are assigned accordingly to the objectives of the project.
		The technical specifications associated to the activities that need to be executed are identified.
Unit Integration	Team Promotion	There is a positive relationship between project team, managers, and other stakeholders.
		Communication between personnel often works in such a way that dangerous situations does not occur.
		Teamwork is regarded as important for project success.
		There is a good relationship amongst the team members.
	Group Coordination	Interdependence amongst stakeholders is recognized.
		The coordination required between the involved parties is clearly specified and monitored.
Open-System Focus	External Monitoring	External project environmental changes are frequently monitored.
		Project teams are capable of responding immediately to changes in the external environment.

Table 21. Continued

CSF	Descriptor	Management Statements
User / Client Involvement	Scope Definition	Limitations of the project were discussed with the clients (what the project is not designed to do).
		The project is designed to accomplish the clients' needs.
	Openness With Clients	The clients are kept informed of specific implementation problems that will affect the output of the project.
		The clients are kept informed of the project's progress.
	Informal Relations	Networking between the stakeholders is encouraged.
		Informal relations between the client and the project team are encouraged to improve their acceptance of the project.
		The project team is organized so that client problems or questions can be fed back to the team for corrective action.
Competent Project Manager	Leadership	The manager's leadership helps to achieve the results.
		The project team has faith in the manager.
	Manager Selection	The manager selection is affected by the technical and interpersonal complexity of the project.
		The related experience to the goals is considered when selecting the manager.
		The manager is well trained in project management theory and practice.
Monitoring and Feedback	Feedback Distribution	Upper management is provided with regular feedback concerning the progress of the project.
		Feedback on project progress is provided on a regular basis.
		Results of the reviews are shared with project personnel who have impact upon budget and schedule.
	Team Meetings	Regular meetings are conducted to monitor project progress and improve the feedback to the project team.
		There are regular communication sessions between the project team.
		When the budget or schedule is revised, the changes and the reasons for the changes are communicated to all members of the project team.
	Progress Monitoring	The actual progress of the project is regularly compared against the project schedule.
		The progress of the project is carefully and systematically monitored.
		The progress of the solution strategies in all "problem areas" are monitored and followed constantly.

Table 21. Continued

CSF	Descriptor	Management Statements
Top Management Support	Project's Importance	Managers recognize the negative consequences of an unsuccessful project implementation.
		Upper management has issued their support of the project, in writing, to all managers and organizational members affected by the project.
	Shared Responsibility	Managers share the responsibility for ensuring the project success.
		Managers are involved in the HSE work on the facility.
		Input from the safety representatives is taken seriously by the managers.
	PM's Trust and Support	Upper management has granted the necessary authority to relevant personnel and will support their decisions concerning the project.
		Managers will support the personnel when needed.
		Personnel have the confidence of upper management.
Control Mechanisms	Trust on Employees	There is a high degree of trust between upper management and team members.
		There is a high degree of trust amongst the various stakeholders.
	Work Environment	Teams are not highly penalized for failures and mistakes.
		Teams are highly monitored on their performance related to cost, time, and quality.
		There are clearly defined control measures for the project procedures.
	Project Understanding	The project team implementing the project understand the activities associated to it.
		The project team personnel understand their role on the project team.
		The project team is aware of the schedule and budget constraints of the project.
Conflict Tolerance	Conflict Criteria	There is a high tolerance for conflict.
		Personnel think there is no pressure not to report personal injury or other events that can "destroy the statistics".
		Politics and power accepted levels are managed before the project implementation.
	Team Correction	Interpersonal conflict and differences are managed in a constructive way for mutual benefit.
		Personnel stop their colleagues if they work on one insecure way
		Team members have the courage to view their criticism openly.
		Personnel find it comfortable to point out violations of safety rules and procedures.

Table 22. Management Assessments for Safety Success Factors

CSF	Descriptor	Management Statements
Organization Chart Clarity	Organization Chart Clarity	The relevant organization charts are up to date.
		The organizations are manned with all necessary roles.
Role Clarity	Role Clarity	Personnel know what to do in an emergency situation.
		The main tasks for all project roles are clear.
		The responsibilities for all project roles are clear.
Role Balance	Control in Role Balance	Personnel can participate in deciding how to perform their work.
		The work is organized such that personnel can improve their skills.
	Demand in Role Balance	There is sufficient time for all work tasks.
		Conflicting demands rarely occur in the job.
		Personnel take necessary breaks during their work.
	Support in Role Balance	Personnel support each other.
		Questions raised to management are responded to promptly.
		Managers will support the personnel when needed.
Governing Documentation	Accuracy of Governing Documentation	The HSE procedures are adequate.
		Safety is threatened due to differing procedures and routines between different offshore installations.
		It is clear what to do in situations where it is not possible to follow governing documentation.
	Accessibility of Governing Documentation	It is easy to access relevant procedures and instructions for the work.
		Information sharing systems, methods and procedures are easy to use effectively and efficiently.
		Relevant information needed to be able to make decisions that safeguard HSE is available.
		It is easy to find relevant governing documentation.
	Comprehensibility of Governing Documentation	It is easy to understand relevant governing documents (requirements and procedures).
		Procedures related to high-risk activities undergo scrutiny.
		The organization offers training in applying governing documentation.
Incentive Criteria	Clear Expectations	There are clear expectations with regard to the personnel's safety behavior.
		Discussions related to safety are encouraged.
		Clear safety performance expectations are established.
		Safety behavior expectations are communicated clearly.
	Support	Personnel is encouraged to follow safety rules.
		Inquiring attitudes are encouraged.
		Personnel's safety initiatives are supported.
	Reward Criteria	Outstanding safety results are openly appreciated.
		Outstanding safety practices are openly appreciated.

Table 22. Continued

CSF	Descriptor	Management Statements
Resource Management	Training (Formal)	There is sufficient time for on-the-job training.
		Sufficient training is in place to enhance an inquiring attitude.
		Personnel are offered adequate training for their work tasks when needed.
		Emergency preparedness training is good.
	Recruitment	There are clear procedures for identifying relevant competence needs in project staffing.
		Safety competence is emphasized in project staffing.
Competence	Knowledge	The personnel have good knowledge of HSE related procedures.
		Relevant safety related training is offered.
		Leaders focus on major safety risk in addition to minor safety risk.
		Personnel recognize the value of safety related information, even if it's not positive.
		Lack of knowledge of new technology can sometimes lead to increased accident risk.
		The project team has a common understanding of the risks associated with the operations.
	Skills	It has been verified that personnel have necessary skills to carry out safety critical tasks in a safe way.
		Personnel have necessary skills to handle an emergency situation.
Value Alignment	Balance Between Enacted and Espoused Values	There is clear acceptance to stop working if proceeding with a work operation can be dangerous.
		Leaders address issues that potentially have serious consequences, not only issues that actually have serious consequences.
		In case of safety critical events, management always look for underlying systemic causes, also in cases where the event was triggered by human error.
		Leaders emphasize safety evaluations when safety critical work activities are being planned.
		Managers set a good example regarding attention to safety.
Learning From Previous Failures	Learning From Failures	Personnel know who in the organization to report to.
		Leaders view incidents and events as learning opportunities instead of finding who to blame.
		Investigations-are focused on lessons learned, continual improvement, and systemic conditions.
		Event information is evaluated to find early signals-that may be precursors to a more severe incident.
		Reporting systems are actively used by personnel.
		Reports about incidents and accidents are often embellished.
		Information about unwanted events is effectively used to prevent repetitions.

Table 22. Continued

CSF	Descriptor	Management Statements
Inherent Safety	Man-Machine Interface / Human Factors	The tools to carry out safety critical work tasks are easily available.
		Tools and components are designed in such a way that misunderstandings are easily prevented.
		The tools to carry out safety critical work tasks are suitable.
	Safety Barrier Functionality	The effectiveness of safety barriers is assessed prior to safety critical tasks.
		The capacity of safety barriers is assessed prior to safety critical tasks.
	Safety Barrier Integrity	Preventive maintenance is carried out according to plan.
		The availability/reliability of safety critical barriers is routinely assessed.
ICT Architecture	ICT Systems' Confidentiality, Integrity, Availability, and User Interface	The ICT systems provide timely and reliable information.
		The ICT systems are sufficient to meet the operational requirements.
		The ICT systems are easy to use in an effective and efficient way.
		Relevant ICT systems are available when needed.
		The tools that are used by the project team provide adequate information flow and accurate data.
Communication	Information Accuracy	Language and cultural disparities are not accounted for when communicating.
		Safety critical information is shared accurately between personnel.
		Communication practices contribute to prevent dangerous situations.
	Information Accessibility (Information - Flow)	Safety critical information is actively shared between colleagues.
		Personnel are informed or made aware of actions taken to address concerns, mistakes, and observations.
		Shift-handovers contribute to sufficient information sharing.
	Information Comprehensibility	Working operations with high risk are always assessed carefully before start-up.
		Uncertainty is dealt with through open communication.

Table 22. Continued

CSF	Descriptor	Management Statements
Cooperation	Cooperation Among Individuals and Groups	Personnel discuss HSE related issues with their manager when needed.
		Cooperation between main company and supplier contributes to prevent dangerous situations.
		Managers are involved in the HSE work on the facility.
		Personnel are very concerned about HSE.
		Communication occurs in both directions, including to and from leaders and across teams, individuals, and organizations.
		Personnel are comfortable with pointing out violations of safety rules and procedures.
		Leaders create an environment that actively encourages differing opinions.
		There is a good relationship amongst the team members.
		Team members have the courage to view their criticism openly.
		There is a high tolerance for conflict.
	Stakeholder Cooperation (Company, Unions, Regulator)	Input from the safety representatives is taken seriously by the management.
		Leaders encourage personnel to communicate openly with the appropriate stakeholders.
		Industry collectively establishes information sharing methods to promote safety.
		The safety delegates do a good job.
	Offshore - Onshore Cooperation	The cooperation between offshore and onshore organizations is good.
		Cooperation between facility and land through the use of ICT systems has led to more secure operations.
Resource Allocation	Resource Allocation	The staffing is sufficient to maintain HSE related issues.
		Upper management understands the amount of resources (money, time, manpower, equipment, etc.) required to implement the project.
		An appropriate amount of responsibilities is assigned to individuals.
		Adequate / appropriate resources are provided to personnel to achieve their work.
		Parallel working operations resulting in dangerous situations are avoided.
		Personnel feel sufficiently rested when at work.

Table 22. Continued

CSF	Descriptor	Management Statements
Leadership in Safety	Task Oriented Leadership	Personnel are encouraged by leaders to work in a safe way.
		Leaders monitor for and act on weak signals or early indicators.
		Leaders actively promote actions and policies that support safety culture.
		Workers are confident that managers will prioritize safety in all situations.
	Relationship Oriented Leadership	There is frequent informal communication between workers and management.
		Leaders recount stories of successes and failures where an inquiring attitude was key to the success or failure.
		Leaders actively listen and discuss safety concerns, visibly act to resolve issues, and plainly communicate outcomes.
		Personnel perceive that their safety and the safety of every person is critically important to everyone in a leadership position.
		Personnel are confident that their leader will support them when they prioritize safety above other demands.
Resource Access	Access to Competence	It is expected to participate in coordination meetings.
		Personnel actively solicit and listen to differing opinions and encourage others to do the same.
		It is encouraged to ask colleagues for advice.
	Access to Corrections	My colleagues stop me if I work in an insecure way.
		Personnel are situationally aware of what might go wrong and challenge the current practice.
		Concerns, mistakes, and observations are addressed visibly and in a timely manner.
		Personnel ask colleagues to stop work that they believe is performed in a risky manner.
		Personnel will notify if they observe dangerous situations.
Commitment to Governing Documentation	Commitment to Governing Documentation	The work permit system is always complied with.
		Personnel comply with safety rules even when they have to get the job done quickly.
		Personnel demonstrate care and concern for their responsibilities.
		Personnel use mandatory protective gear.
		Governing documentation is always followed, even when experienced colleagues are involved.
		Relevant safety related risk is assessed, evaluated, and treated.
Trust	Trust	There is a high degree of trust between upper management and team members.
		Leaders do not imply that the information they are receiving is not valid.
		Personnel have confidence in upper management.

Table 22. Continued

CSF	Descriptor	Management Statements
Power	Power Over vs. Power To	Personnel can influence HSE conditions in their workplace.
		Leaders do not retaliate, nor do they tolerate retaliation, in any form.
		Regulations and procedures related to HSE are sufficient.
	Formal vs. Informal Power	Negative group pressure does not influence on HSE reporting.
		The boundaries between acceptable and unacceptable behaviors are clearly understood and are the same for everyone.
		Personnel are encouraged, both formally and informally, to report personal injury or other events that may "destroy the statistics".
	Position Power, Information, and Expertise	Leaders react to safety concerns irrespective of the position of the messenger.
		Leaders visibly and proactively encourage personnel to discuss concerns, mistakes, and observations without fear of retaliation.
		Being concerned about HSE is an advantage with regards to career.
Goal Balance	Work Pressure	Use of overtime work to finish safety critical work tasks is limited to maintain safety.
		Safety is prioritized above efficiency.
	Balance Between Production and Safety Performance	Safety is prioritized higher than production.
		Personnel are never pushed to work in conditions they do not consider safe.
		Managers appreciate when pointing out aspects in significance for HSE.
	Balance Between Company, Unions, and Regulator	The safety representatives are involved in decisions related to HSE.
		There is a high degree of trust amongst the various parties.