Comparison and Effective Approaches for Quantitative Risk Assessment (QRA) Oil & Gas Offshore Installation

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Abstract

The methods to determine Quantitative Risk Assessment (QRA) used in Malaysia are different amongst industries, consultants & asset facilities within various practitioners have slightly cause different QRA results. The differences concern both ways of the calculations are performed and the consequences calculated (such as deaths). Despite the differences, the methods yield similar results in terms of the safety distances. There has been increasing interest in using oil & gas QRA offshore installation to help improve the primary objectives of QRA. In Malaysia oil & gas, chemical process and petrochemical industries are primarily concerned with determining in terms of "individual." Individual Risk Per Annum (IRPA) or "societal" Location-Specific Individual Risk (LSIR) caused by undesired events. Specialist software can also be used to model the effects of such an event, and to help calculate the potential loss of life. QRA for offshore oil and gas installations is supported by the Centre for Marine and Petroleum Technology (CMPT) guide. This guidance focuses on estimating risk for specific scenarios such as blowouts, leaks, fires and evacuations. Following high-quality guidance material is likely to result in higher-quality instances of QRA. However, complying with guidance is not in itself sufficient to ensure that a QRA is free of major gaps. The paper provides a constructive way forward model for assessing and improving QRA. In order to qualify for a given level, a QRA process and report must be free of the gaps in all levels. This paper has proposed a model which indirectly provides a roadmap for organizations to develop & improvise offshore oil& gas QRA practices. The paper highlighted about the how safety practitioners to improve their QRA practice and justifies allocation of resources. QRA should has an important role to play in system safety engineering, but to realize its benefit it needs to be conducted effectively and appropriately.

Keywords: *QRA; Comparison; Effectively*

1. Introduction

Quantitative risk assessment (QRA) is a consolidated approach to evaluating the risk level of an industrial system, which is traditionally based on the main technical failures leading to potential accident scenarios [1].

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In the development of Malaysia offshore design engineering, technical safety or process safety team has a duty and responsibility for any risk study carried out on their undertaking. It is including the QRA design engineering activity.

There could be no value or insignificant engineering deliverables resulted risk assessment from a QRA service provider or consultant which could only resulted as a normal record engineering practice for design project development practices. Nor is there value in carried out a generic risk assessment that does not fully address issues significant to the offshore installation [2]. It is better to spend money on remedial measures rather than detailed quantified risk assessment. Effectively or practically risk assessment is essential to ensuring that money is effective spent. Therefore, an initiative needs to be valued in deciding the approach to risk assessment required. The QRA provider or consultant should make use of the results of the risk assessment as part of the continuous improvement of safety output, e.g. by using it to identify possible effective remedial measures such as development for critical operational safety management guideline or specific safety procedure.

The ownership of the design phase risk assessment needs to be retained by the technical safety engineers. The engineer will therefore need to carefully consider how to supply the data input required by the consultant, including details of the installation and its operation. In all cases, practitioner carrying out the risk assessment should have a good knowledge of the asset being studies. They are responsible for producing a risk assessment that is fully appropriate for the installation and purpose, rather than a generic risk assessment for the type of installation.

Where consultants are employed to carry out the risk assessment, their scope of work would be expected to include the making of effective remedial measures about the potential for further risk reduction. The technical safety engineer is responsible for evaluation of these recommendations.

1.1 Background

In Malaysia, QRA is established technique used risks assessment for offshore installation. The technique is increasing used throughout the design processes or planning phase during offshore project development. QRA is widely used to support safety system decision making by Malaysia industry, regulators and government.

QRA is widely practiced in safety system, but there is insufficient evidence that QRA in general is fit for purpose or being standardized used by the operators. The QRA is only identified between poor or misused QRA and correct used QRA, this subjective issue to discuss by QRA practitioner, but this is only useful if we have robust ways to identify the gaps in an individual QRA. In this paper we present a model for QRA which covers all the potential gaps discussed in the risk assessment literature and collection of actual offshore installation study case risk assessment reviews selected for this paper. This paper also provides validation of the expert survey for the gaps identified and provide proposed guideline for effectiveness model.

The paper resulted for a guideline model which provides a way to standardize QRA technique amongst the Malaysia offshore oil & gas selected practitioners in particular for offshore Semi-Submersible Floating Storage Offloading (FPS), floating production storage offloading (FPSO), Floating Liquid Natural Gas (FLNG) and Fixed Platforms

1.2 Problem Being Investigated

Even though in Malaysia QRA is widely practiced as a common safety system assessment, but there is insufficient evidence that QRA in general is fit for purpose or being standardization among the practitioner. There are many challenges in continual development of QRA models as a decision support technique. In common issues need to be looked into consideration are including a consistency in QRA model, QRA practitioner knowledge of analysis, QRA output presentation and ability to update existing QRA studies.

1.3 Reason in Conducting Research

The paper is intended to provide a constructive way forward model for assessing and improving QRA expected results with cost saving benefits. In order to qualify for a given level, a QRA process and report must be free from differential or gaps in all levels. By identifying the gaps in this way, the proposed model should provide a roadmap both for operators to develop their single QRA practices or in common, Malaysia QRA practitioners could target the most important real-safety offshore installation problems.

Furthermore, the comparison which has identified gap classification study for this paper has built a model for effectiveness QRA, the model use for efficiently improvement technique guideline and scale the quality QRA against which approaches can be measured, and the paper can investigate level risk of the operators involved resulted from the differentiate QRA techniques being used. Selected study cases for comparison are studied from the typical offshore installation Semi-FPS, FPSO, FLNG & Fixed Platform.

2.0 Method

2.1 How the Study is Performed

A key step is to understand the gaps and which offshore installation QRA can go wrong. The next step is to understand the relative importance of those gaps so that we can priorities research into them.

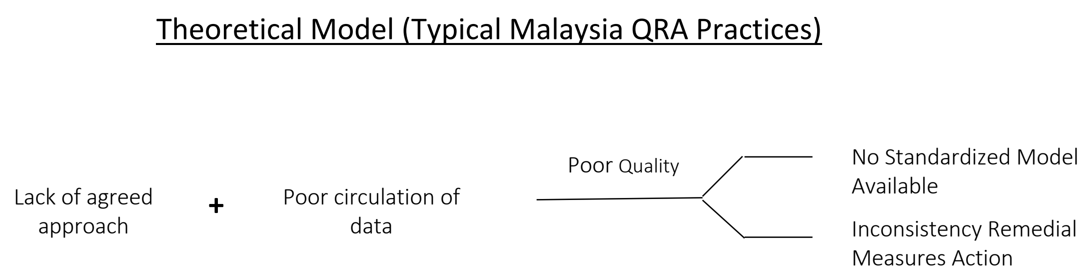

Figure 1. Theoretical Model (Typical Malaysia QRA Practices)

In order to identify study parameters, list of potential parameters is developed from CMPT, as for evaluating QRA. An indicator of low quality or high quality are accumulative total of 25 numbers questions are used as a typical parameter whether the operator QRA practiced are rated as low or high. It is also be utilized as a guideline to identify those assessed offshore installation QRA is fully compliance, partial aligned with CMPT requirement or it is not aligned at with CMPT recommended practices.

The paper has resulted three (3) common high raking comparison or common gaps;

a. Concentration of modelling and risk reduction effort on hazards that do not take priority risks
b. Lack of attention to risk reduction measures
c. Use of cost benefits analysis to relate risk reduction measures to the estimated risks

In this paper, expert survey was compared against the gaps identified. The comparison exercises detailed in this paper were also supported by rating each risk caused by the differentiate results, and it has shown that it is adequate and with strong claims that what are common QRA high ranks and how necessity is follow up action for improvement benefit or action taken the remedial measured.

In means, the primary objectives of risk assessment in this context are to identify and rank the risks so that they can be adequately managed and to examine associated risk reduction measures to determine those most suitable for implementation.

The effectiveness of the current offshore installation QRA can be defined as [3]:

$$\text{Effectiveness} = \frac{\text{Work Output}}{\text{Work Input}} \times 100\%$$

P = Parameter

No of Practical QRA = P_n

(Practical=Compliance with the CMPT Quality Parameter)

Total no. of Practical QRA= $\sum Pt$ or 25 Parameters

No. of Practical QRA required for QRA improvement = V or Impractical

Total no. of Practical QRA required for QRA improvement = $\sum Vt$

$$\text{Current QRA Practical (\%)} = \frac{\sum Pt - \sum Vt}{\sum Pt} \times 100$$

QRA effectiveness = the most percentage effective QRA for Offshore Installation

$$\text{Current QRA Effectiveness} = P_1\sum_{\Delta RA(1)} + P_2\sum_{RA(2)} \ldots\ldots + P_n\sum_{RA(n)} \times 100\%$$

$$\overline{\qquad P_T \qquad}$$

P_n = No of Parameter [1 = Practical : 0 = Impractical]

P_T = Total Practical = 25

RA = Agreed Remedial Action

ΔRA = Remedial Action Done divided by Total Agreed Redial Action at Parameter n = unit in ratio

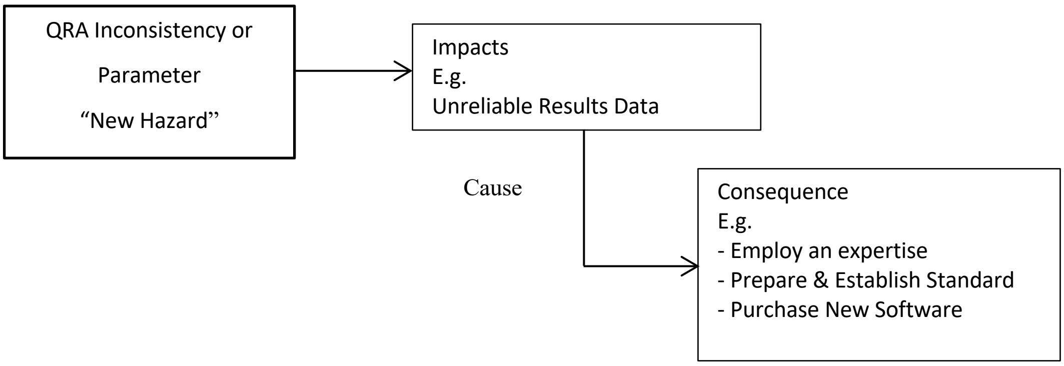

Figure 2. Theoretical scenario identification

Each parameter differentiates or gaps were analyzed their rating as table qualitative matrix table, as shown in Table 1. Study indicated slightly different in tolerable rating risk. Remedial measure may not necessary, but remedial measures action is needed for the operational phase safety management improvement.

Table 1. Qualitative Risk Matrix

IMPACT		Severity	1 Insignificant	2 Minor	3 Moderate	4 Major	5 Catastrophic
LIKELIHOOD	E Almost Certain	Happen several times per year at location	E1	E2	E3	E4	E5
	D Likely	Happen several times per year at company	D1	D2	D3	D4	D5
	C Possible	Incident has occurred in our company	C1	C2	C3	C4	C5
	B Unlikely	Heard of incident in industry	B1	B2	B3	B4	B5
	A Remotely likely to happen	Never heard of in industry	A1	A2	A3	A4	A5

Key:	Low	Medium	High	Intolerable

Severity Description

	ASSET
1	Slight damage - no disruption to operation (costs less than 10,000)
2	Minor damage - Brief disruption (cost less than 100,000)
3	Local damage (Partial shutdown) (can be restarted but costs up to 500,00)
4	Major damage - Partial operation loss (2 weeks shutdown costs up 10 mil)
5	Extensive damage - Substantial or total loss of operation (cost in excess up to 10 mil)

Table 2. Risk Treat Table

Risk Categories	Risk Treat	Description
Intolerable	Intolerable/Unacceptable	Work cannot proceed before the risk reduced to ALARP or Tolerable
High	ALARP	Work may proceed but continuous improvement required reducing risk at tolerable level.
Medium		
Low	Tolerable	Work may proceed. Current controls are adequate. No action is required.

2.2 Effectiveness Supported by Cost Benefits

Quantitative As Low As Possible (ALARP) estimate of the available spend to achieve ALARP can be obtained from the following:

$$\text{Cost} = \frac{\text{Benefit of injuries prevented} + \text{benefit of avoided damage/escalation}}{\text{EAC}} \times 100\%$$

Where: EAC (estimate asset cost) is estimate can used the severity asset table.
Benefit = ($ per injury) x Δ (number x frequency) x (remaining lifetime)
($ per injury) is the estimated average compensation value for an injury. Δ (number x frequency) is the change in the product of number affected (consequence) and frequency, due to the risk reduction measure(s) under consideration. Number = number of injuries.
Benefit of avoided damage = (change in frequency due to risk reduction) x (cost of avoided damage)
The increasing percentage results should show more effective remedial measure taken.

2.3 Results Contribute Scientific Knowledge

To address the concerns raised the paper can make significant observations. An identified problem is effectively progress solved if we can prioritize risk that is needed. If we find different levels of evidence of specific problems, we will then, similarly, need to priorities improvements to fix those problems which occur most often (or with the greatest negative impact).

2.4 Emphasize Findings

The risk understanding is getting more mature, it is suggested that risk assessment should now become increasingly focused on where it can add value (e.g.

in evaluation of risk reduction options) rather than provided as normal planning assessment. Thus, any risk assessment should answer the fundamental question of whether there is anything more that can be done to reduce the risk, while adding value. There is also a shift in focus from providers owned risk assessment back to operators.

2.5 Discussion & Conclusion

QRA is lack of standardization. Some operators recognize this problem and how it impairs ability to compare risk levels between different installations. Most operators decided to contract provision of QRA services, but could be various providers have been tasks to different projects, not a single provider for developing a consistent approach. The operator should require standard provider or single QRA technique. It will have advantages such as consistency results amongst installation, cost can be spread over a number of projects and justify user manual & training materials, Malaysia authority should enforce single QRA provider or using one (1) QRA technique in any offshore installation. The next issue is whether the oil companies need to know the instantaneous risk level on their installations. It may be argued, this would be however, a rather conservative interpretation of the requirements. Also, the requirements for risk acceptance criteria by Malaysia authority regulations indirectly call for such a detailed quantitative study, but should nevertheless also be open for debate and discussion. This is a separate subject for a future study.

Alter all, a more cost-effective solution from operators Safety Management perspective, whereby the where a number of remedial actions are assessed in more detail, according to what the need may be. Not all of these detailed studies may be possible to integrate into an overall value, if they do not have a common expression of the consequence expectation.

The risk assessment methodology applied should be efficient (cost-effective) and of sufficient detail to enable the ranking of risks in order, for subsequent consideration of risk reduction.

2.6 Suggestion of Practical Results

Common practices results have been more integrated with the design process and lacks recommendation for operation phase such as safety management improvement to benefits the operational aspects. The diversity QRA approaches has led to inconsistencies in output.

Based on requirements whereas if new Malaysia regulations will take in place and learnt from the experience “traditional” QRAs, the move forward QRA studies will be improved and added values to the operational phase.

Typical problems where decisions are required in the operational phase and where decision support from a well-developed ORA will increase the probability for the ‘correct’ decision, are identified to be such as whether the activity should be carried out or not, what restrictions and safety related aspects that should be taken care of in daily operation, what the requirements to the equipment are , what the requirements to the personnel and the competence are or whether the production should be shut down or not whether the manning level must be changed

2.7 Recommendation

In order to get more benefit from QRAs and hence an improved ability to identify cost effective safety improvement, a number of steps are suggested such as Malaysia organization should implement QRA standardization for all Malaysia offshore operator in term of single technique, service provider and balance of assessment which also focusing on QRA recommendation or remedial measure actions.

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