International Journal of GEOMATE, Jan., 2017, Vol. 12, Issue 29, pp. 178 - 185
Geotec., Const. Mat. & Env., ISSN: 2186-2990, Japan; DOI: http://dx.doi.org/10.21660/2017.29.97136

EVALUATION OF SAFETY ENGINEERING SYSTEM IN OIL AND GAS CONSTRUCTION PROJECTS IN UAE

Ghanim Kashwani*, Yasemin Nielsen

School of Energy, Geoscience, Infrastructure and Society (EGIS), Heriot Watt University, UK.
Centre of Excellence in Sustainable Building Design.

*Corresponding Author; Received: 10 July 2016; Revised: 18 July 2016; Accepted: 20 July 2016

ABSTRACT :Risk assessment is one of the most critical tools used in the safety engineering system in oil and gas construction projects due to it providing the required protection for the construction activities such as pilling, materials fabrication, and structure installation. The main purpose of risk assessment tool is to provide full protection to the four main elements that are crucial to the oil industry: People, Environment, Assets and Reputation (PEAR). The failure or defect in the risk assessment implementation in the construction stage can potentially lead to catastrophes in the advanced stages such as operation and productions. In oil and gas construction projects many historical oil spill and blow outs occurred due to a lack of efficient risk assessment in the construction phase, resulting in financial and human life losses. There are various factors that contribute to the implementation problem in the construction phase, thus, different aspects should be analyzed in the risk assessment structures to determine how the system is very closely linked. Through data analysis, it is evident that the weakness in the implementation can be related to inadequate policy and framework of the risk assessment. Organizational culture affecting employee safety behavior is another contributing reason for faulty implementation. Many scholars try to analyze the implementation problem in the oil and gas sector, along with other heavy industries, through risk regulations, risk planning and human error. This research exposes the defects and challenges in the risk assessment tool in oil and gas construction projects in UAE through a questionnaire survey. The research shows a gap in the understanding and practice of the risk assessment tool between management and operation, especially in the behavioral effects.

Keywords: Construction project, Risk assessment, Safety regulations, Behavioral based safety, Safety culture

1. INTRODUCTION

1.1 Health and safety in construction projects

Construction is a very dynamic and complex industry, facing numerous challenges. According to Reyes et al., [1] Health and Safety (HS) can play a vital role in preventing and mitigating all critical risk factors and this only can be achieved by ensuring the implementation of HS matters in the whole construction project life cycle. The authors believe that construction industry has a high accident rate compared to other industries due to the complexity of construction factors, possessing a social, human and economic dimension. Haslam et al., [2] provide examples of these dimensions, listing inadequate training, large number of subcontractors, lack of proactive culture, and an inadequate risk assessment. The authors mention that these negative factors can be prevented and controlled in the design phase before they escalate and affect the whole project. This can be achieved through accurate hazards identification techniques such as Task Risk assessment (TRA), Hazard Identification (HAZID), and Hazard and Operability Study (HAZOP). Cheng et al., [3], however, suggests that all HS matters in the organization can be addressed and implemented effectively if there is a specific system such as Health, Safety and Environmental Management System (HSE-MS). The author explains that in any construction project, the safety engineering system has become critical to construction due to the legislative and regulatory requirements in the country along with the company's reputation and social responsibility.

Usually in construction and operations sites, a multitude of safety problems occur frequently each year, leading to injury and potentially affecting an employee's long-term health [4]. In order to improve the safety engineering system and reduce accidents as well as personnel injuries, the HSE-MS must be constantly improved at construction sites. HSE-MS in construction sites ideally should contain the concepts and principles that are used in the development and management of an effective HSE program. The HSE-MS plan should be continuously improved with particular emphasis on organizational issues [5]. For example, special attention should be given to elements such as morale influence, education and training, the role of the supervisor, inspections, auditing, policies and risk assessment.

Coble et al., [6] maintain that risk assessment is one of the most vital elements in addressing all the HS engineering matters of the construction building project life cycle where internal factors can have direct influence on the risk assessment implementations. Internal factors that may affect the risk assessment implementation in the construction company are insufficient communication, perceived budget viability and production/time pressure.

1.2 The history of safety engineering system in oil and gas construction projects

Oil and gas construction projects have witnessed many historical catastrophes that eventually laid the groundwork for professional practices to the industry [7].

These serious safety failures resulted in huge financial losses and environmental impacts, and increased awareness in the oil and gas construction world towards safety implementation in the construction activities such as structure installation, foundation pilling, and materials fabrication. According to Cohen, [8] financial damages in oil and gas construction can have a major impact on the company's profit profile since these damages link directly with decrease in production and downtime losses. For the environment damages, Ronza et al., [9] believe that oil and chemical spills are the main environmental threats in the oil and gas construction projects damaging vital ecological elements such as soil, natural habitat, and marine life. Ronza et al mention that the oil and gas construction companies often fail to comply with environmental requirements until the regulatory authorities like Environmental Protection Agency (EPA) start imposing penalties and fines. These legal penalties present the wake up call to the whole oil and gas industry to adopt proper tools to control hazards at construction sites. As a result, the oil and gas construction industry adopted risk assessment methods from other industries to ensure efficient risk control and mitigation [10].

1.3 The history of risk assessment in oil and gas construction projects

Unfortunately, risk assessment applications in safety engineering system have been developed after numerous serious incidents where inadequate risk assessment in the construction phase was the root cause for these incidents. According to Davies [7], many of these serious incidents occurred in the operation phase that could have been controlled had the risk assessment been effectively implemented in the construction stage.

- Alexander L. Kielland capsize (North Sea, 1980)

Due to fatigue cracks that caused major collapses in the bracing members of the rig structure, 123 workers were killed in this fatal accident. According to Moan, [11], the main technical failure that lead to this huge accident occurred in the design phase where load distributing was not measured correctly thereby it affecting the welding mechanism. In addition, the author believes that escape and evacuation process were not carried out efffectively due to the poor emergency preparedness and limited access. For example, there was only one life boat that was launched to safe more than 80 workers.

- Ixtoc I. Blowout (Gulf of Mexico, 1979)

Boehm and Fiest, [12] consider Ixtoc I. Blowout disaster to be one of the historical spills in the oil and gas construction industry. It caused a massive contamination area (180 km x 80 km) due to a well control issue during the operation. It is clear that there was no equivalent point between hydrostatic and formation pressures where the increase in the formation pressure generated a fluid kick that later developed into a blowout. According to the authors, technical failures in the well head design affected Blow Out Preventer (BOP) function and led to loss control of the well. As result, around 3.5 million barrels of oil spilled into the Gulf of Mexico.

- Piper Alpha Explosion (North Sea, 1988)

Davies [7] mentions that Piper Alpha accident is considered one of the most famous fatal accidents in the oil and gas business industry. 167 workers lost their lives in this tragedy due to the removal of a safety valve from a compressor, resulting in a gas leak which caused a major fire. However, Dives believes that apart from this active failure (direct cause), other technical, procedural and behavioral causes played a critical role in escalating this catastrophe. To illustrate, the following point represents the latent failures as mentioned in American Petroleum Institute [13]:

1. Lack of effective communication between crew member (behavioral)
2. Not applying Permit to Work system (PTW) adequately (procedural)
3. Continued pumping of gas and oil by the Tartan and Claymore platforms (Technical)
4. Poor emergency plan

- Deepwater Horizon Blow Out (Gulf of Mexico, 2010)

Eleven workers were killed and more than 4 million barrels of crude oil was spilled in Gulf of Mexico due this huge blowout. According to Rathnayaka et al., [14], the main technical failure that led to this catastrophe was inadequate cementing in the completion phase that marred the well control process. It is clear that, due to the poor quality of cementing in the down hole during construction and high formation pressure, hydrocarbons were released and reached all the way to the drilling column causing an explosion where it was hard to control the kick by BOP because of the its high volume. In addition, the authors state that other invitation reports indicated safety management failures such as leadership, communication and managing resources were classified as root causes for this fatal accident. Therefore, risk assessment can be considered as one of the most critical protection tools used in oil and gas construction. In oil and gas construction projects, any failure in the risk assessment could lead to major catastrophes [15, 16, 17]. All these potential disasters have huge negative impacts at different level. Risk assessment tool examines closely all the activities that may take place in the oil and gas construction projects. The main purpose of risk assessment is to provide full protection to the four main elements that are of utmost importance to the company i.e. People, Environment, Assets and Reputation (PEAR) from any harm in the work place [18] as shown in Fig. 1.

Fig.1: Risk Assessment seek to improve the four (PEAR) elements

The history of risk assessment starts with the insurance companies that are associated with Industrial Revolution, which took place from the 18th to 19th centuries, in different businesses [19]. When large capital investments were made in the industrial business, it was necessary to understand, manage, control and calculate the risk. In the beginning of 1980, EPA required a worst environmental scenario description in the application for the entities who are applying for the environmental permit. After that, other agencies started to implement the concept of risk assessment. For example, in 1982 the Minerals Management Service (MMS) in United States developed the environmental and safety regulations for the offshore oil and gas industry [20]. The severity of accidents as those mentioned here makes the industry sector to realize the importance and need of risk assessment to protect them from multiples hazards in the workplaces.

In the beginning, the concept of risk assessment pertained to perspective regulation than to performance regulation. It is clear that, in perspective regulation, the assessment of risk will be more in terms of equipment and the technologies used in the event without defining and analyzing the risk itself, which is the case of risk based on performance regulation. The risk based on performance regulation has evident role in controlling, analyzing and mitigating the risks. For instance, when the risk assessment is developed, most of the risk assessment techniques classify the risk based on its severity and frequency and then they propose mitigation plans to control the hazards. Unfortunately, usually the development of risk assessment in oil and gas field comes after the occurrence of serious incidents. For example, following the Alexander Kielland accident in the Norwegian offshore rig in 1980, the petroleum authorities in Norway required that risk assessments had to have risks with a probability higher than once every 10,000 years [21]. This is very similar to other real incidents in which the main lesson learned was to strengthen risk assessment, thus enabling risk assessment to take a major role in every oil and gas construction company regulations. This demonstrates the growth of risk assessment from usage as tool to a mandatory regulation to any hydrocarbon operating facility.

2. PROBLEM STATEMENT

Risk assessment implementation is not a new challenge for the safety engineering system in the oil and gas industry, where many famous cases study of failed risk assessment result from a lack of risk assessment implementation. For example, the Control of Major Accident Hazards (COMAH) report by Health and Safety Executive (HSE) [22] mentions that the root cause of the 2005 Buncfiled explosion (Oil storage) in Hertfordshire Oil Storage Terminal was the lack of the safety implementation in the construction design stage. The report maintains that the safety prevention implementation measures that should be taken were fuel escaping safety measures. This would have helped prevent escape of flammable vapour and stop pollutants from poisoning the environment. Moreover, the report mentions the following points to cover the gap in safety/risk assessment implementation:

- Safety management was not conducted for critical equipment
- Working hours load on the staff was high and employee welfare should be considered

- Poor communication between designers and suppliers in the usage of the critical equipment
- Environmental response plan was not in place as it is recorded in the emergency plan
- Visibility and leadership were not presented and implemented in an effective way in the safety management

When one examines the investigation report, it appears that the risk assessment implementation issues impact not only the construction stage but also primary stages like policy, planning, committed leadership development, and visibility of the company. It is clear that, risk assessment implementation may not be so clear in these stages but it poses a direct connection with operational implementation. For example, high profile management involvement in the safety activities should appear in the following safety events; meeting, awareness campaign, auditing, and inspection. This will set a good example for the operation employees (end-users) to place safety on the top of their priorities when performing their jobs.

There are statistics that showed that the UAE oil and gas construction rigs face the same challenges towards risk assessment implementation. Al Kurdi [23] maintains that the first reason behind incidents in oil and gas construction rigs in UAE is due to the lack of safety engineering implementation. Al Kurdi believes that there is a necessity to provide an integrated framework that can enhance the implementation mechanism.

3. METHODOLOGY

3.1 Questionnaire

The aim of this study is to evaluate the implementation of safety engineering system in oil and gas construction through risk assessment tool in UAE. To do so, three objectives should be examined, where these objectives contain three different aspects; technical, procedural, and behavioral. Each objective has different methodology in order to be achieved in this research Andersen and Mostue [24] conducted an experiment to evaluate risk analysis and risk assessment approaches that are applied in the petroleum industry in Norway where they used a survey to determine the risk analysis methods of different oil and gas construction companies in Norway and to expose the challenges in the risk assessment tool.

In this study, the same approach will be employed and a survey will be utilized to determine the risk analysis and identification methods of the UAE oil and gas construction rigs, along with their weaknesses that affect the implementation of risk assessment.

Beatrice [25] claims that it is vital to collect qualitative data on examining the role of human factor towards safety implementation. Questionnaire survey is a very effective way to conduct this examination because it helps the examiner to be closer to the employees’ world and observe the challenges they face and those which affect the behavioral safety. For example, educational background and work pressure will be analyzed through the questionnaire survey. This will help identify the hidden human factors that influence the risk assessment tool.

3.2 Questionnaire design and distribution

The questionnaire includes 5 major questions which targeted all employees working on the oil and gas construction projects in UAE. There are three main categories or classifications for the construction companies: owners (government sectors), contractors, and vendors, where most of construction projects are located in the onshore fields. As UAE is one of the leading countries in the onshore oil and gas industry, the onshore oil and gas construction projects are considered priority projects given their association with drilling, production, and development. This explains why construction contractors are more readily available in onshore rigs as opposed to offshore rigs.

Consequently, the majority of the questionnaires in this research where distributed in onshore construction rigs. Most construction rigs are located in remote areas both for onshore and offshore fields, rendering electronic communication difficult. Personal visits are required to ensure that the targeted employees from the management to the construction end-user level receive and understand the questionnaires. In this research, 10 personal trips to different construction rigs, including 7 onshore and 3 offshore construction rigs, were conducted to distribute the questionnaires.

3.3 Statistical significance

The sampling method chosen for the purpose of this research is stratified random sampling. Many safety engineering professionals consider stratified random sampling an effective tool to measure the safety performance in construction and various other industries. For example, Hofmann and Stetzer [26] explain that using stratified random sampling in construction safety can help produce diverse experimental cells that contain managers and construction labourers from various owners and contractors companies in a way that gives a precise representation for the targeted population. In addition, Aksorn and Hadikusumo [27] agree in utilizing stratified random sampling as a desirable statistical tool to analysis safety factors in construction due to the different companies with diverse responsibilities that are involved in the same construction project. As such, stratified random samples were selected in this questionnaire. Under the 95% confidence internal for a population of about 4000 employees and a margin of error of about 5%, a representative sample size was calculated to be around 350 employees.

In this research work, Z score test was applied to verify the statistical significance for the following statements in the questionnaire where several scholars such as Goncalves et al., [28] suggest using Z score test (two tailed) with stratified random sampling method. In addition, Lee et al., [29] use Z score test as a statistical approach to determine the level of safety culture in different industries including construction.

The following equation and parameters were used for the Z score test:

$$z = \frac{P1 - P2}{\sqrt{P(1-P)\left(\frac{1}{n1} - \frac{1}{n2}\right)}}$$

Equation1: Z score test Equation for two Populations

P1 = Proportion (or total number) of individuals from sample Population 1 (Total Number of Managers) that have agree or strongly agree with the statement of the question.

n1= Total number of Population 1 (42 Managers).

P2 = Proportion (or total number) of individuals from sample Population 1 (Total Number of Labourers)) that have agree or strongly agree with the statement of the question.

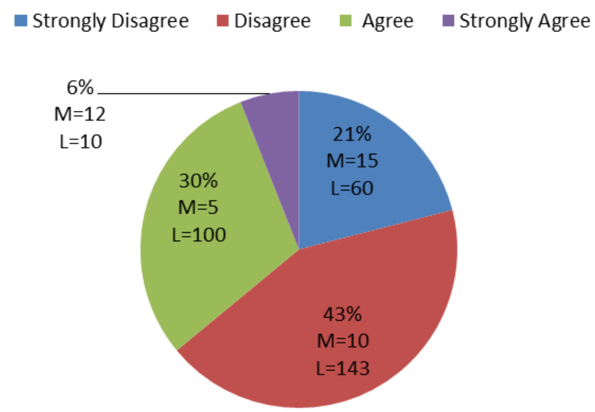
n2= Total number of Population 2 (313 Labourers).

Confident Level (CL) = 95%.

Pooled sample proportion (P)= (p1 * n1 + p2 * n2) / (n1 + n2)

4. RESULT AND DISCUSSIONS

The first question was geared towards gauging the knowledge level of the employees with risk assessment tools such as HAZID, HAZOP, Bowtie, etc, that are used in their construction companies in the oil and gas industry.

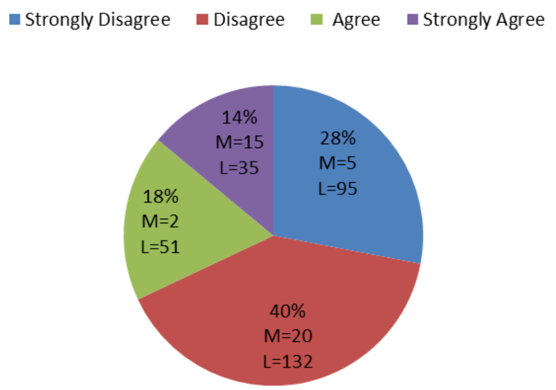


Z value= 0.677 , P value= 0.496

Fig.2: Familiarity with risk assessment based tools

Based on Fig.2, one can argue that most the employees lack sufficient knowledge of these tools. The 43% who disagree are from the end users employee category. This can indicate a lack of training for the construction labourers which can cause serious safety issues due to the high exposure level with all identified potential hazards. To avoid any of these incidents because of the lack of risk assessment skills, Schieg [30] suggests that risk assessment courses should be available for all the employees in the organization, including labourer and technician, where many of the construction companies try to improve the risk assessment skills only for senior decision-making staff. The author believes that a common error that construction companies make is their belief that risk assessment tools are only conducted in offices. Upon analyzing Fig. 29, it can be noticed that 21% strongly agree on the familiarity with risk assessment tools and all of these responses came from senior engineers or managers. This supports Schieg statement about how construction companies predominantly focus upon developing the risk assessment skills for the senior staff without involving other employees.

The second question explicates one of the most important points regarding the employee development i.e. the professional safety development at the construction organization. Champan [31] claims that most construction companies do not provide technical safety courses for their employees. This is especially true in the case of construction labourers.

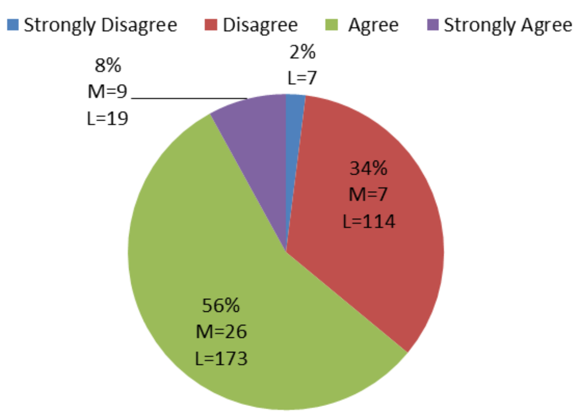


Z value= 3.201, P value= 0.001

Fig.3: Quality of the training courses providing by the company

This explains why many of the end user staff lacks even the basic understanding of safety construction procedures in their organization. This is the reason why the question mentions the word "enough" to examine the respondent's opinion about the training courses that he/she is receiving. As shown in Fig. 3, 40% (mostly senior staff members) do not believe they have enough safety courses required for their jobs. Additionally, 14% who strongly disagree about the current safety courses hold managerial posts.

In the third question, the questionnaire explores the procedural features and effects on the risk assessment implementation in the safety engineering system in the individual and group level. The very first procedural document that any employee should have is the job description that highlights the employee's role and responsibilities including the safety one at the construction site.

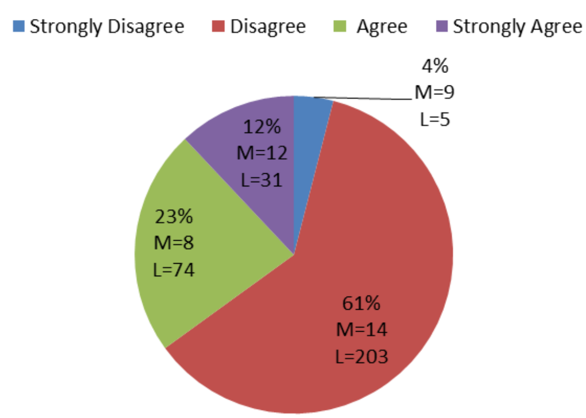


Z value= 2.787 , P value=0.005

Fig.4: level of understanding to your role and responsibilities towards safety in your job

As shown in Fig. 4 that there are two main responses for this question: first, 56% who agree that they understand their safety responsibilities comprise mostly of end user staff members. The second category of responses (34%) came from mostly from construction labourers or top managers who lacked a full understanding of their safety responsibilities in. This is a highly troubling result because these two roles should have a solid understanding of their safety duties. Most construction managers in the oil and gas industry are held accountable for any safety incidents arising at the construction site. For the construction labourers, they should totally understand all technical and the procedural producers that are associated in their construction activities since they are highly exposed to all the potential hazards at the construction field.

Following this, the questionnaire focuses on the technical safety at the construction site in which equipment safety takes an essential part of the operation safety at the construction sites. Cann et al.,[32] expound that to ensure operation safety in construction activities, there are three important aspects that should be covered in construction: reliability, availability, maintainability. The author explains that these elements aid construction inspectors in evaluating the equipment safety for current and future instances, which will improve the implementation of safety system on a long term basis. For example, the authors add that during the risk assessment stage all the reliability insurance tests and maintenance records of construction equipment should be studied. This will prevent any fatigue failure that may occur due to over usage at the construction site. Moreover, the authors suggest all reliability records, especially of the heavy static and mobile equipment used at the field, should be made available along with the safety construction engineer to implement the risk assessment effetely.

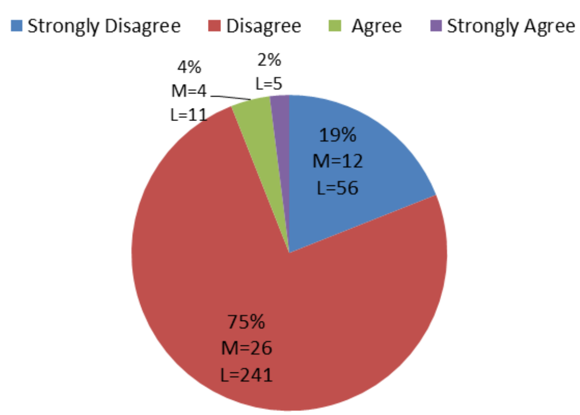


Z value=1.793, P value=0.073

Fig.5: Equipment safety in the construction fields.

Figure 5 shows that most employees disagree about the safety equipment safety at the construction site where 61% of the respondents hold managerial posts. This raises the question about the asset management role in implementing the safety system in their construction organizations.

Focusing on the individual level, last question in the questionnaire starts highlighting the commitment of the construction organizations to raise behaviour safety awareness via campaigns or other activists. According to Mearns and Yule [33] many of the oil and gas firms conduct different safety and environmental activities that focus only on the technical and procedural aspects (maintenance and emergency workshops) without embracing behavioural based safety.



Z value=1.164 , P value=0.246

Fig.6: Behavioral safety activities effectiveness level.

The results in Fig. 6 mirror the authors' statement where 75% of the respondents, from all employee categories, disagree about the occurrence of safety Behavioral based safety awareness. The authors claim that the absence of such activates directly impacts the safety engineering system at the construction site.

5. CONCLUSION

The gap between management and end-users is obvious from this questionnaire. These gaps become even more pronounced when the questionnaire examines the behavioural safety aspect at the construction activities as the 75% of the respondents reflect in Fig. 6. This is critical because even if all potential procedural and technical hazards are assessed without considering the behavioural safety factors, it will not be effective to simply guarantee the integrated safety at the site. For instance, according to Dey [34], human factors play a root cause in most major incidents during oil and gas construction. As such, it is vital to analyze human factors during risk assessment stage.

This questionnaire exposes several areas that directly influence the safety engineering system, especially the risk assessment tool, varying from technical, procedural, and behavioural features. It shows the need of integrated risk assessment framework. This will help to have a tool that can embrace all the verity areas; technical, procedural, and behavioral which interact with the safety engineering implementation. The weakness in the implementation in the safety system can be related to the inadequate risk assessment. The scenario of faulty implementation of risk assessment tool might be due to the organizational culture that affects the safely behavior of the employee. There are various scenarios and assumptions in theory but which ultimately fail in deciphering the real cause and effect of the implementation problem for oil and gas construction projects.

Due to that, further investigation is necessary to understand the reasons and risk factors behind why these challenges exist inside the construction organization, particularly between senior management and labourers. Such an investigation will help reach the aim of this study i.e. providing an integrated framework to optimize the safety engineering system in the oil and gas industry. This can be approached through interviewing construction professions who possess a complete view pertaining to the current barriers and issues for safety implementation at the construction sites.

6. REFERENCES

[1] Reyes, J. P., San-José, J. T., Cuadrado, J., & Sancibrian, R. (2014). Health & Safety criteria for determining the sustainable value of construction projects. Safety science, 62, 221-232.

[2] Haslam, R.A., Hide, S.A., Gibb, A.G.F., Gyi, D.E., Pavitt, T., Atkinson, S., Duff, A.R., (2005). Contributing factors in construction accidents. *Applied Ergonomics* 36 (4), 401–415.

[3] Cheng, E.W.L., Ryan, N., Kelly, S., 2012. Exploring the perceived influence of safety management practices on project performance in the construction industry. Safety Science 50, 363–369.

[4] Yong, C., &Yonghua, Q., (2004). On the Promotion and Application of HSE Management System at the Grassroots Safety, Health and Environment, 4(2), p. 26-29.

[5] Mikkelsen, A., Ringstad, A. J., & Steineke, J. M., (2004).Working time arrangements and safety for offshore workers in the North Sea. Safety Science, 42 (3), 167-184.

[6] Coble, R.J., Haupt, T.C., 2000. Potential contribution of construction foremen in designing for safety. In: Proceedings of the Designing for Safety and Health Conference. W99, European Construction Institute, Publication TF005/4, pp.143–150.

[7] Davies., (2010). Deep Oil Dilemma. Engineering & Technology, 5 (8), pp. 112-212.
[8] Cohen, M. J. (1995). Technological disasters and natural resource damage assessment: an evaluation of the Exxon Valdez oil spill. Land Economics, 65-82.
[9] Ronza, A., Lázaro-Touza, L., Carol, S., & Casal, J., (2009). Economic valuation of damages originated by major accidents in port areas. J. of Loss Prevention in the Process Industries, 22(5), pp. 639-648.
[10] Aven, T., (2009).Perspectives on risk in a decision-making context – Review and discussion. Safety Science 47, pp. 798–806.
[11] Moan, T., (2007). Fatigue reliability of marine structures, from the Alexander Kielland accident to life cycle assessment. International Journal and Polar Engineering, pp. 1-22.
[12] Boehm,P. D., and Fiest, D. L., (1982). Subsurface distributions of petroleum from an offshore well blowout—the IXTOC I blowout, Bay of Campeche. Environmental Science and Technology.16, pp.67-74.
[13] The Lessons of Piper Alpha (8th of April, 2008). Oil and Gas UK. A presentation given to industry graduate employees.
[14] Rathnayaka, S., Khan, F., Amyotte, P., (2013). Accident modeling and risk assessment framework for safety critical decision-making: application to deepwater drilling operation. Journal of Risk and Reliability. 227 (1), 86–105.
[15] Hauge, K., Blanchard, A., Andrersen, G., Boland, R., Grosvik, B., Howell, D., Meier, S., Olsen, E., &Vikebo, A., (2014). Inadequate risk assessment- A study on worst-case scenarios related to petroleum exploitation in the Lofoten area. Marine policy, 44, 82-89.
[16] Elshorbagy, W., &Elhakeem, A., (2008). Risk assessment maps of oil spill for major desalination plants in the United Arab Emirates. Desalination.228, 200-216.
[17] Shahriiar, A., Saidq, R., &Tesfamarim, S. (2012). Risk analysis for oil & gas pipelines: A sustainability approach using fuzzy based bow-tie analysis. Journal of loss prevention in the process Industries. 25,pp. 505-523.
[18] Aven, T., Vinnem, J.E., &Wiencke, H.S., (2007).A decision framework for Risk assessment, with application to the offshore oil and gas industry. Reliability Engineering and System Safety 92, 15–24.
[19] American Bureau of Shipping (2000).Risk Assessment Applications for the Marine and Offshore Oil and Gas Industries. Houston, USA.
[20] Scarlett, L., Linkov, I., &Kousky, C. (2011). Risk assessment Practices: Cross-Agency Comparisons with Minerals Management Service. Washington, DC.
[21] Norwegian Petroleum Directorate, (1989).Guide-Lines for Security evaluation of platform concepts.
[22] HSE, (2011). Buncfiled: why did it happen? Control of major accident hazards.
[23] Al Kurdi, O., (2008). Improving Road Safety in Corporate Fleet Settings – engaging technology, people, Government Organizations (police) and Non Government Organizations (NGOs). SPE-111800.
[24] Anderesn, S., and Mostue, B., (2012). Risk analysis and Risk assessment approaches applied to the petroleum industry and their applicability to IO concepts. Safety Science 50, 2010-2019.
[25] Beatrice, O., (2011).Influencing safety culture in the UK Offshore Oil and Gas Industry: The importance of employee involvement. Master thesis: The Robert Gordon University.
[26] Hofmann, D. A., & Stetzer, A. (1998). The role of safety climate and communication in accident interpretation: Implications for learning from negative events. Academy of Management J., 41(6), 644-657.
[27] Aksorn, T., & Hadikusumo, B. H. W. (2008). Critical success factors influencing safety program performance in Thai construction projects. Safety Science, 46(4), 709-727.
[28] Goncalves, R.P., Assis, L.C. and Vieria, C.A.O., (2007). Comparison of sampling methods to classification of remotely sensed images. IV International Symposium in Precision in Agriculture, 23-25 October, Vicosa, Brazile.
[29] Lee, T. Z., Wu, C. H., & Hong, C. W. (2007). An empirical investigation of the influence of safety climate on organizational citizenship behavior in Taiwan’s facilities. International Journal of Occupational Safety and Ergonomics, 13(3), 255-269.
[30] Schieg, M. (2009). Model for integrated project management, Journal of Business Economics and Management. 10(2):149–160.
[31] Chapman, R. J. (2001). The controlling influences on effective risk identification and assessment for construction design management. International Journal of Project Management, 19(3), 147-160.
[32] Cann, A. P., Salmoni, A. W., Vi, P., & Eger, T. R. (2003). An exploratory study of whole-body vibration exposure and dose while operating heavy equipment in the construction industry. Applied occupational and environmental hygiene, 18(12), 999-1005.
[33] Mearns, K., & Yule, S. (2009). The role of national culture in determining safety performance: Challenges for the global oil and gas industry. Safety science, 47(6), 777-785.
[34] Dey, P. K. (2004). Decision support system for inspection and maintenance: a case study of oil pipelines. Engineering Management, IEEE Transactions on, 51(1), 47-56.