



Development of Work-based Vestibule Training E-module For Accident Prevention at Malaysian Oil and Gas Drilling Industries: A Proposed Framework

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DOI: <https://doi.org/10.30880/ijscet.2020.11.02.012>

Received 30 July 2020; Accepted 30 August 2020; Available online 02 September 2020

Abstract: This article discusses the conceptual action plan and detailed methodology for the identification of potential hazard controls and the development of work integrated E-vestibule training module for safe onshore and offshore oil and gas drilling operation at Malaysian industries. According to the previous studies, there is a sheer industrial need of an effective work integrated vestibule training module for accident prevention at oil and gas drilling sites at Malaysian drilling domains. In this proposed study, 80 drilling crew will be randomly selected for quantitative research phase. Similarly, 03 safety experts will be purposively selected for qualitative research from each drilling domain. Whereas, for the identification of hazard controlling measures What-If analysis and thematic analysis approaches will be adopted. Furthermore, the open source vestibule training module will be developed by using ADDIE based on identified hazard controlling measures. However, the visual studio and MySQL software will use to develop the E-Module for drilling crew safety training. The proposed E-vestibule training module development framework will be used as an effective source for the elimination of life-threatening drilling hazards associated with its activities at oil and gas industries. Similarly, the proposed framework can also be implemented on other work-based learning training designs. Moreover, this proposed safety and health vestibule training module will be the first E- drilling safety module which covers all onshore and offshore drilling operation in Malaysian oil and gas extraction settings.

Keywords: Occupational Safety and Health, Oil and Gas, Drilling Operation, Industrial Workforce, E-Systems

1. Introduction

Oil and gas industries play an important role in driving the global economy because of its consumption as basic fuel ranging from household to widespread industries. According to the hazardous nature of oil well drilling process, drilling operations are considered as an area of high potential risk for drilling crew (Blackey et. al., 2014). Every year large number of fatalities and accidents are reported during both off and onshore drilling (Brenner, Brett & James,

2015). There are many hazards and risks coupled with drilling which can cause serious injuries and accidents (Blackey et al., 2014; Brenner, Brett & James, 2015). In the proposed study, effective hazard controls and mitigating measures associated with potential hazardous operation will be identify and implement for reducing workplace risks and hazards in drilling process at oil and gas industries in Malaysia. Similarly, for the identification a work-based vestibule training E-Module will be developed for accident prevention at onshore and offshore drilling site at Malaysia. In this study, sequential exploratory research design will be adopted which will consist on preliminary and post research analysis. Both qualitative (semi structure interview) and quantitative (Survey Instrument) methods will be used for analyzing the effectiveness of safety training module and performance of drilling crew after using the proposed module. The proposed E-Module will assist and facilitate the drilling crew and safety officers for the identification of effective hazard controls of potential drilling hazards. It will also help to implement appropriate controls as per safety protocols according to the OHS acts and regulations in both domains to prevent the injuries in hazardous work environment of oil and gas industries. Moreover, the respondents for this research will be randomly selected health and safety experts and drilling crew of major onshore and offshore oil and gas operations in Malaysia (PETRONAS). This study also might help and act as a reference for those who are conducting work-based safety trainings (training consultants) in oil and gas companies and for vocational training of drilling crew for health and safety during drilling process. Likewise, this study will also figure out the effectiveness of the proposed safety training module for accident prevention at onshore and offshore oil and gas drilling sites in Malaysia.

1.2 Safety Hazards in Oil and gas Drilling

Drilling process is the most important process in oil and gas industries while being hazardous and challenging (Benneer, 2015). Due to the lack of work-based drilling health and safety awareness, high fatality rate among oil and gas drilling crew has been reported (Ingraffea et. al., 2014). In the years 2007–2012, the occupational fatality rate of the oil and gas drilling industry was 2.5 times higher than the construction industry and 7 times higher than general industry (Skogdalen & Vinnem, 2012). This industry's fatal injury rate is correlated with fluctuations of industry activity, as measured by the number of active drilling rigs (Sprehe, 1999). Fatality rates are highest during drilling process, which demands increased efforts for improved safety strategies at drilling rigs (Benneer, 2015). Many of the workers that survive in such disastrous incidents are vulnerable to other health concerns. These health effects include dizziness, headaches, drowsiness, nausea and vomiting as well as dermatitis and deep skin tissues infections from repeated skin contact with the drilling fluids (Kargbo, Wilhelm & Campbell, 2010). Some of the mildly refined base oils have also been associated with cancer, as a result of the aromatic compounds in the oil mists (Kargbo, Wilhelm & Campbell, 2010).

According to Saudi Aramco oil refinery statistical analysis from year 2008-2013, the highest rate of critical injuries was reported in drilling process (Sprehe, 1999). In the context of Malaysia, during past five years several deaths and critical injuries has been reported during working at onshore and offshore drilling sites. In June 2012, during oil and gas extraction and refining operation more than 23 critical injuries have been reported due to explosion at Kerteh in Malaysia (Wiseman, 2009). Similarly, In October 2014 during Malaysia's Sapura Kencana offshore rig operation, a technician and a mechanic, were inspecting a safety boat on the rig before the boat suddenly fell into the sea due to lack of safety measures, both workers died from head injuries reported by Malaysian news agency (Brenner, Brett & James, 2015). According to the online statistical information provided by department of safety and health, 68 fatalities and 74 permanent disabilities have been reported in year 2016 at manufacturing and petroleum industries in Malaysia (Medina & Krasuk, 2015).

Firstly, there are many factors involved in high rate of drilling fatalities and critical accidents and injuries (Livingston et. al., 2016). Due to the rapid change in environment, technology and complex drilling approaches drillers and safety engineers have to face new challenges every day regarding health and safety. For this reason, there is a need to identify potential hazards with their effective controlling measures based on hierarchy of controls for reducing workplace risk and hazards at onshore and offshore oil and gas industries in an effective manner (Medina & Krasuk, 2015).

Secondly, there is a lack of proper and effective health and safety training E-module which can enhance the performance of drilling crew during performing drilling operation (Asad et. al., 2018). For the elimination of variety of hazards and risks in drilling operation, there is a sheer industrial need of an efficient training guideline and module for drilling personnel with updated knowledge and hazard controlling measures according to the international safety regulation (Asad et. al., 2018). Therefore, in this proposed study it is intended to tackle the aforementioned issues by developing a drilling health and safety module based on effective controlling measures for reducing workplace risk and hazards at onshore and off shore oil and gas industries in Malaysia for prevention of accidents at onshore and offshore drilling domain. The main objective of this study is to propose a framework for the development of a drilling safety and health training E-module for reducing workplace risk and hazards at offshore and onshore oil and gas industry in Malaysia.

1.3 E-Modules for Health and Safety

Based on the detailed literature review from over last ten years different online modules have been developed for oil and gas related vestibule trainings worldwide [(Medina & Krasuk, 2015)]. But there is no such E-module available in the industries with mutually integrated onshore and offshore oil and gas drilling operations based on effective hazard controls and mitigating measures (Asad et. al., 2017). Table 1 reflects the name of existing online resources and modules for health and safety of oil and gas and their countries with industrial domain based on detailed literature review.

Table 1 - Previous Related Work

Name of System	Origin	Domain
Permit Control & Monitoring System (PCMS)	UK	Oil and Gas
SPONCOM	USA	Mining
Confined Spaces Advisor 1.1	USA	Chemical Industry
Fire Safety Advisor 1.0a	USA	Oil and Gas
DUST-Expert	UK	Oil and Gas
Hand-arm Vibration Calculator	UK	Construction
Hazard Awareness Advisor 1.0	USA	Construction
EASE System	UK	Oil and Gas

2.1 Framework Development for Oil and Gas Drilling Safety

This section covers the detailed explanation of methodology that will be used to conduct and pursue this study. Plenty of preparation should be done to produce a best quality of research study in order to ensure all plans can be done in an orderly and systematic manner. To implement this study, various parts need to be observed in terms of hazard controlling measures identification approach, mix method research design, development approach for vestibule E-Module, study instruments development and data analysis. The flow of this proposed study is shown in flowchart in Fig 1.



Fig. 1 - Flow Chart of Proposed Study

2.2 Hazard Controlling Measures Identification Approach

For the identification of suitable hazard controlling measures qualitative data will be analyzed through What-if Analysis approach for extracting meaningful and detailed information through in-depth semi structured interviews from health and safety experts. What-If Analysis is considered as an effective method for determining the hazard controls

(Asad et al., 2017). It is done by asking questions on the basis of potential hazards and related recommended actions for those risks judged by field experts. Because of the nature of this hazard control identification technique it is required to identify the associated hazards related with onshore and offshore drilling activities prior to identify appropriate controls. In the context of identifying hazards and their controls thematic analysis approach with tabular representation will be adopted for interpreting the findings of all drilling operations. Main themes will be developed on the bases of the characteristics of hazards and their appropriate controls as shown in Fig. 2.

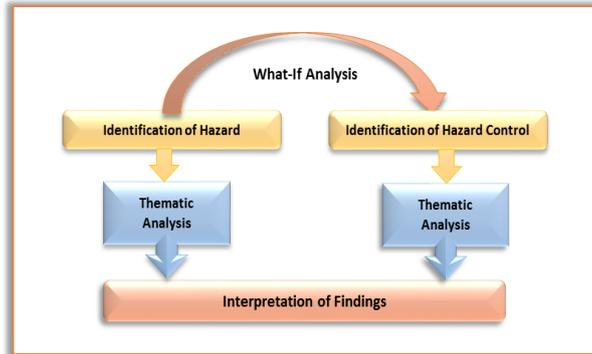


Fig 2 - Block Diagram for What-If Analysis (Asad et al., 2017)

2.3 Survey Instrument Development

Study instrument or measuring instrument of study is essential to achieve the objectives of the study. In this proposed study, instruments which will be used for quantitative research are two questionnaires. The survey instrument for the identification phase has been used for the recognition of potential oil and gas drilling hazards and their appropriate controls at onshore and offshore drilling domains in targeted industry. In this phase both quantitative and qualitative (Survey and Semi-Structured Interview) research methods will be utilized for answering the proposed questions. After the identification of effective hazard controlling factors and mitigation measures for reducing workplace risks and hazards at oil and gas drilling sites, a Vestibule Training E-module will design and develop. Once the E-Module developed, then an implementation research phase will be conducted for analyzing the impact of effectiveness of Vestibule Training E-module for user satisfaction and performance of drilling crew for vestibule safety training at onshore and offshore drilling sites by employing the survey instrument for the evaluation phase of this study. Moreover, the research questionnaire development is divided in five major phases as described below (Asad et. al., 2018):

I. PHASE I (Indicate the Area of Construct)

The first phase for designing research questionnaire is to identify the domain of construct. In this study, construct for preliminary and post research questionnaire will be identified and designed by referring previous research instruments during literature review. In the first step of research questionnaire development, researcher must know about the factors and variables of his research before design of research questionnaire (Asad et. al., 2018). As the area of construct is identified, then proceed to second phase which is designing of draft instrument according to the identified domain.

II. PHASE II (Designing of Draft Instrument)

In the second phase of designing research questionnaire, the researcher has to construct a draft for research instrument and need to analyze the relevant information and knowledge which will help for gathering required information from the respondents of the study (Asad et. al., 2017). Once the drafts of questionnaire are ready, then move to next phase which is content validation and overall validation of research questionnaire from experts of that field.

III. PHASE III (Validation from Expert)

In the third phase of questionnaire design, validation of research questionnaire is conducted which is the most important process because the whole study finding depends upon research instrument. In this phase, researcher will validate the clarity of questions, layout, technical information, and wordings of designed questionnaire from the experts of that particular field (Asad et. al., 2017). In the context of this study rubric assessment tool will be adopted from Asad et al., (2018) for assessing the validity of identification and implementation research phase of survey instruments. After finalizing the draft of survey questionnaires, researcher will validate the research instruments from the four (04) field

experts by sending the designed research instruments to them with rubric assessment form for validation. Criteria and parameters of rubric assessment as listed in Table 2.

Table 2 - Rubric Assessment Criteria and Parameters (Asad et al., 2018)

Criteria	Parameters
Clarity	<ul style="list-style-type: none"> The questions are direct and specific. Only one question is asked at a time.
Wordiness	<ul style="list-style-type: none"> The participants can understand what is being asked. Questions are concise. There are no unnecessary words
Negative Wording	<ul style="list-style-type: none"> Questions are asked using the affirmative.
Overlapping Responses	<ul style="list-style-type: none"> No response covers more than one choice. All possibilities are considered. There are no ambiguous questions.
Balance	<ul style="list-style-type: none"> The questions are unbiased and do not lead the participants to a response. The questions are asked using a neutral tone.
Use of Jargon	<ul style="list-style-type: none"> The terms used are understandable by the target population. There are no clichés or hyperbole in the wording of the questions.
Effectiveness of Responses Listed	<ul style="list-style-type: none"> The choices listed allow participants to respond Effectively. The responses apply to all situations or offer a way for those to respond with unique situations.
Use of Technical Language	<ul style="list-style-type: none"> The use of technical language is minimal and Effective. All acronyms are defined.
Application to Praxis	<ul style="list-style-type: none"> The questions asked to relate to the daily practices or expertise of the potential participants.
Relationship to Problem	<ul style="list-style-type: none"> The questions are sufficient to resolve the problem in the study The questions are sufficient to answer the research questions. The questions are sufficient to obtain the purpose of the study.

IV. PHASE IV (Pilot Study)

In the fourth phase of designing research questionnaire, after validation from the experts, researcher will conduct pilot study to test the designed instrument and to find out the respondent's feedback in answering the questions, and to improve the reliability and validity of the survey instrument (Asad et. al., 2018). In this research, pilot study will be conducted for both survey questionnaires. This pilot survey was tested by 35 health and safety professionals and drilling crew at Malaysian oil and gas industry (PETRONAS).

V. PHASE V (Finalizing Instrument)

In the last phase of designing research questionnaire, after pilot study from the respondent, researcher will finalize the research questionnaire according to the response and feedback from pilot study (Hassan et. al., 2017). In this study, researcher will finalize the research questionnaires according to the comments and response from the field experts and then further proceeded to the final study of research.

2.4 ADDIE Model for Vestibule Safety Training Module Design

ADDIE model is followed for the development of training systems and multimedia technologies (Asad et. al., 2018). In the context of this study, ADDIE model of instructional and training design will be used for planning and designing of drilling health and safety module for Malaysian oil and gas drilling processes. ADDIE model is based on five main steps like: Analyze, Design, Development, Implement, and Evaluate.

I. Analysis Phase

In the analysis phase of this model, problem should be simplified and well-defined. In this phase of ADDIE, the developer should know very well about the audience (Targeted population) or learner's needs, objectives and content required before instructional design (Babbie, 1990; Eifert et. al., 2000). In this initial phase, performance and

achievements of learner and training purpose and its expected outcomes are also analyzed. In the context of this study, drilling health and safety training module will be developed for vestibule safety training of drilling crew for reducing workplace risk and hazards.

II. Design Phase

The designing phase of ADDIE model deals with learning goals and designing the instructional materials which can help us in the development of delivery instruments, exercises and practices, developing content of teaching material and lesson planning and media selection for the delivery to the audience (Hassan et. al., 2017; Babbie, 2000). The learning goals of vestibule training in this research is to enhance the health safety performance of drilling crew by identifying hazards before working at actual drilling.

III. Development Phase

The development phase is where the developers form and gather the content assets that were generated in the previous phase of ADDIE Model. This development phase almost depends upon design phase. In this study, it consists of several stages such as specifying the hazard controlling measures, learning objectives from training, assign roles and responsibilities, prepare documentation because organization and planning is very important for systematic process. In this phase, the developer should identify the available media and its performance.

IV. Implementation Phase

The Implementation phase is where the developed course is actually placed into action and monitored with its implementations. After previous phases, the work or planning performed in the design and development phase is now applied on the audience (Drilling crew) for further outcomes. In the context of this research, proposed drilling safety training module will be tested on the drilling crew at Malaysian oil and gas industries to assess the effectiveness of drilling safety training module for accident prevention and training activities.

V. Evaluation Phase

This phase involves an ongoing process or activity in all phases after every stage and reviews the feedback and evaluates results from learners. In the first phase of analysis, the evaluation can determine if there is a problem and its potential solution (Livingston, 2016).

2.5 Research Paradigms

A research paradigm differentiates the set of ideas, thoughts and assumptions that guide the direction and philosophy of the researcher in reaching the knowledge needed to draw conclusions for the study (Asad et. al, 2018; Asad et. al, 2017). In other words, the research paradigm influences the research design with the intention of providing quality research outcomes (Asad et. al, 2018; Asad et. al, 2018; Asad et. al, 2017; Hassan et.al., 2017; Babbie, 1990). The main purpose of this research design is to adopt pragmatic research paradigm that will support both qualitative and quantitative approaches to answer the research questions (RQ). Creswell (2017) have pointed out a number of pragmatic and mixed-methods characteristics as including:

- i. Appropriateness of the study and findings.
- ii. A mixed method that advocates the proficient use of both quantitative and qualitative methods.
- iii. The research questions being more important than the methodological approach of research.
- iv. The methods match the purpose of the research questions.
- v. The approach is practical and applicable to the type of research presented.

In accordance with that, this research will present the appropriate instruments of preliminary and post quantitative survey for major data collection and focus group interviews to further examine data findings from the survey instruments.

2.6 Mixed Method Research Design

Mixed methods research is a research design with philosophical assumptions as well as methods of inquiry (Asad et. al, 2017). It involves philosophical assumptions that guide the direction of the collection, analysis of data and the mixture of qualitative and quantitative approaches in many phases in the research process. As a method, it focuses on collecting, analyzing, and mixing both quantitative and qualitative data in a single study or series of studies. Its central premise is that the use of quantitative and qualitative approaches in combination provides a better understanding of research problems than either approach alone. Some of the advantages of using a mixed-methods approach in research design include:

- i. Mixed methods provide more comprehensive evidence and help to answer the research questions (Asad et. al, 2018)
- ii. Mixed-methods research is able to answer the RQs that the other methodologies cannot accomplish by simultaneously answering the confirmatory and exploratory questions; it can therefore verify and generate theories in the same study (Asad et. al, 2017; Hassan et.al., 2017).

2.7 Sequential Explanatory Research Design of Study

A mixed-methods study employs sequential use of different methods rather than the integration of data analysis (Eifert et. al., 2000). The sequential (Explanatory, Exploratory, and Embedded) method uses both quantitative and qualitative data, which are implemented and connected at different phases. In sequential explanatory research design, quantitative follows the qualitative findings. It means that quantitative research is conducted firstly and based on the attained findings; qualitative research is conducted for the in-depth understanding and validity of quantitative research findings (Hassan et. al., 2017). This design is relatively effective to implement and describes findings well where mixed methods are employed. Furthermore, a sequential explanatory mixed-methods research design is chosen because multiple methods and techniques can be used to provide the most complete understanding of the research problems (Babbie, 2990).

This study will adopt the strategy of sequential explanatory research method for preliminary and post research phases in order to obtain maximum information from the findings to answer and justify research questions. In this study, both quantitative and qualitative results will be analyzed individually to answer the research questions lying under preliminary research (RQ1, RQ2) and post research (RQ 3). The qualitative data (focus group) will be collected and analyzed second in the sequence which will help to explain, or elaborate on, the quantitative (questionnaire) results which are obtained in the first phase. Then, the corresponding findings will be compared for expanding the understanding of research in order to see if there are similarities and differences. By using this approach, in data analysis for mixed-methods or triangulation approaches, the qualitative data may support and even confirm the quantitative results. The qualitative data and their analysis refine and explain those statistical results by exploring participants' views in more depth (Ingraffea et. al., 2014).

2.8 Quantitative Research Design and Analysis

Quantitative research design is used to quantify the problem by way of generating numerical data or data that can be transformed into useable statistics (Eifert et. al., 2000). It is used to quantify attitudes, opinions, performance, and other defined variables. Quantitative research uses measurable data to formulate facts and uncover patterns in research by using appropriate statistical techniques (Asad et. al., 2018) In this study, quantitative research method will be used for answering the proposed research questions. Whereas, for the quantitative data and hypothetical analysis, descriptive (Mean, Standard deviation and Percentage) and inferential statistical approaches (One-way ANOVA) will be used for achieving proposed objectives for accessing the effectiveness of the proposed drilling health and safety training module for accident prevention at onshore and offshore oil and gas drilling sites. For quantitative study, from each drilling domain, 80 oil and gas drilling crew will be randomly selected from each drilling domain as shown in Table 3.

Table 3 - Respondents of Quantitative Phase

Domain	Industry	No of Respondent
Onshore	PETRONAS	80
Offshore	PETRONAS	80
Total		160

2.9 Qualitative Research Design and Analysis

Qualitative research design will be used to get valid information to address the proposed research questions in this study. In qualitative research design section, hazard identification and effectiveness of drilling safety and health training module will be analyzed by using What-If Analysis and thematic analysis approaches from health and safety professionals at onshore and offshore drilling industry in Malaysia. Three health and safety experts will be purposively selected for semi structured interviews as shown in Table 4.

Table 4 - Respondents of Qualitative Phase

Domain	Industry	No of Respondent
Onshore	PETRONAS	03
Offshore	PETRONAS	03
Total		06

2.10 Development of Proposed E-Module

For the development of work-based vestibule training E-Module for accident prevention during drilling operations, two software will utilize according to the appropriate functionality and previous research studies as shown in Table 5. While, for the development of graphical user interface of E-Module, Visual Studio VB.NET will be used due to its user-friendly environment and ability of handling almost any amount of data, up to as much as 50 million rows or more (Wiseman, 2009). Similarly, for inference engine, rule base method with structural quires will be adopted, because rule base method provides natural knowledge representation and deal with incomplete and uncertain knowledge (Asad et. al., 2017). Similarly, MySQL (2015) will be used for the development of knowledge base (KB) of the proposed module along with expert opinion for drilling accident prevention activities based on health and safety rules.

Table - 5 Work Based Safety E-Module

E- Module Development	Tool and Method
Graphical User Interface	Visual Studio (VB.NET)
Inference Engine	Rule Base Method and Structural Quires
Knowledge Base	MySQL (2015)

2.11 Proposed Research Instruments

In this study, instruments which will be used for quantitative research are two questionnaires. The preliminary research questionnaire will use for identification of the major hazardous drilling operations, potential hazards with their suitable controlling measures. In preliminary and post research both quantitative and qualitative research methods will be utilized for answering the research questions.

After the identification of major controlling measures for reducing workplace risk and hazards in drilling process, drilling health and safety training module will be designed and developed. Once the module will be developed, then a post research will be conducted for analyzing the effectiveness and safety performance of drilling crew after utilizing proposed module based on controlling measures for accident prevention and training activities at Malaysia. Research questionnaire development phases will be adopted for both questionnaire development and Rubric assessment tool which will be used for the validation of questionnaire (Asad et.al., 2017; Hassan et. al., 2017).

2.12 What-If Analysis Approach

What-If analysis approach has been employed in this study for the identification of potential hazards along with their effective and suitable hazard controls to eliminate and reduce the workplace risks at Malaysian, Saudi Arabian and Pakistani onshore and offshore oil and gas industries during drilling operations. This approach is considered as one of the most advanced and effectual qualitative assessment for the identification of problematic industrial operations and their preventive controls (Asad et.al., 2018). Additionally, the flexibility of the What-If Analysis approach can be applied to nearly any industrial operation, process or activity, either existing or planned (Asad et.al., 2017). Moreover, it can be successfully applied to the routine and non-routine activities, equipment maintenance and service works (Hassan et. al., 2017).

3 Expected Outcomes and Conclusion

This research article proposed the detailed framework and methodology for the development of drilling health and vestibule safety training E-module based on identified effective hazard controls and mitigating measures in support of accident prevention and work based vocational training activities. The proposed E-module will assist and facilitate the safety professionals and drilling crew to prevent the injuries in hazardous work environments of onshore and offshore oil and gas industries according to international safety standards. This proposed E-module will be the first work-based E-Module which has potential to implement at onshore and offshore drilling domains in Malaysian drilling industries. Similarly, the proposed E-Module will also use for vocational teaching and training purpose at educational institutes for vestibule training activities associated with onshore and offshore drilling operation.

Acknowledgement

This research work and manuscript publication has been sponsored by Universiti Tun Hussein Onn Malaysia (UTHM) under the TIER 1(H209) grant.

References

Asad, M.M., Hassan, R.B., Ibrahim, N.H., Sherwani, F. and Soomro, Q.M. (2018). Indication of Decision Making through Accident Prevention Resources among Drilling Crew at Oil and Gas Industries: A Quantitative Survey. In Journal of Physics: Conference Series, 1049(1), 012022. IOP Publishing

- Asad, M.M., Hassan, R.B., Sherwani, F., Ibrahim, N.H. and Soomro, Q.M. (2018). Level of Satisfaction for Occupational Safety and Health Training Activities: A Broad-Spectrum Industrial Survey. In *Journal of Physics: Conference Series*, 1049(1). 012021. IOP Publishing.\
- Asad, M.M., Hassan, R.B., Soomro, Q.M. and Sherwani, F. (2017). Development of KBES with Hazard Controlling Factors and Measures for Contracting Health and Safety Risk in Oil and Gas Drilling Process: A Conceptual Action Plan. *The Social Sciences*, 12, 584-594
- Babbie, Earl. (1990). *Survey research methods*. Belmont, CA: Wadsworth. Google Scholar
- Benneer, L.S. (2015). Offshore oil and gas drilling: a review of regulatory regimes in the United States, United Kingdom, and Norway. *Review of Environmental Economics and Policy*, 9, 2-22
- Blackley, D.J., Retzer, K.D., Hubler, W.G., Hill, R.D. & Laney, A.S. (2014). Injury rates on new and old technology oil and gas rigs operated by the largest United States onshore drilling contractor. *American journal of industrial medicine*, 57, 1188-1192
- Brenner, Brett, & James C. Cawley. (2015). Occupations most at-risk in fatal overhead power line incidents: Using osha data to get a better understanding. In *Electrical Safety Workshop (ESW), IEEE IAS*, pp. 1-6
- Creswell, John W., and J. David Creswell. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage publications
- Eifert, G.H., Thompson, R.N., Zvolensky, M.J., Edwards, K., Frazer, N.L., Haddad, J.W. and Davig, J. (2000). The Cardiac Anxiety Questionnaire: development and preliminary validity. *Behaviour research and therapy*, 38, 1039-1053
- Hassan, R., Asad, M.M., Soomro, Q.M. and Sherwani, F. (2017). Severity of the Casing and Cementing Operation with Associated Potential Hazards in the Drilling Process in the On and Offshore Oil and Gas Industry: A Cross-Sectional Investigation into Safety Management. *Pertanika Journal of Social Sciences and Humanities*, 25, 129-138
- Ingraffea, A.R., Wells, M.T., Santoro, R.L. & Shonkoff, S.B. (2014). Assessment and risk analysis of casing and cement impairment in oil and gas wells in Pennsylvania, 2000–2012. *Proceedings of the National Academy of Sciences*, 111, 10955-10960
- Kargbo, D.M., Wilhelm, R.G. & Campbell, D.J. (2010). Natural gas plays in the Marcellus Shale: Challenges and potential opportunities
- Livingston, D.A., Andes, D., Czerneski, M., Bauer, S., Castro, B., Gorr, K., Coffman, R. and Beebe, L., March. (2016). Team approach to horizontal drilling optimization in the Marcellus delivers record setting performance. In *IADC/SPE Drilling Conference and Exhibition*. Society of Petroleum Engineers
- Medina, J. & Krasuk, R. (2015). Cementing operation in underbalanced casing drilling: A successful case history in an unconventional shale reservoir in Argentina. In *SPE/IADC Managed Pressure Drilling and Underbalanced Operations Conference & Exhibition*, Society of Petroleum Engineers
- Skogdalen, J.E. & Vinnem, J.E., (2012). Quantitative risk analysis of oil and gas drilling, using Deepwater Horizon as case study. *Reliability Engineering & System Safety*, 100, 58-66
- Sprehe, P. R. (1999). U.S. Patent No. 5,890,549. Washington, DC: U.S. Patent and Trademark Office
- Wiseman, H., (2009). Untested waters: The rise of hydraulic fracturing in oil and gas production and the need for revisit regulation. *Fordham Env'tl. L. Rev.*, 20,115