Study the Impact of Safety Awareness Program (SAP) as Moderating Variable for Reduction of Accidents in Oil and Gas Industry – A Proposed Framework

Mohammed Ismail Iqbal [a*], Ibrahim Alrajawy [b], Osama Isaac [c], Ali Ameen [d]

[a] Lincoln University College, Selangor, Malaysia
[b,c,d] Lincoln University College, Selangor, Malaysia
* Correspondence: ismailiqbal@lincoln.edu.my

Abstract

Hydrocarbon Industry stands any country's backbone for social strength and economic development. The oil and gas industry provide variety of products that help people in daily life everyday hence it is very important to tackle the problems faced during the operation of a drilling rig in order to prevent wastage of time and money as well as huge accidents like kick followed by blowout may take place. The literature is evident to say that there is not only high risk to personnel working in field but also to environment and assets in Oil & Gas Operations. As per the report of IOGP (International Association of Oil and Gas Producers) it is observed that percentage of accidents is second highest in drilling domain. The occurrence of accident pattern in Oil & Gas industry is to be considered otherwise than the traditional accident occurrence theories. Largely the causes of accident in hydrocarbon industry is due to failure of barriers which are primarily related to human behavior. Hence this research aims to propose a framework to understand the various factors like personal factors, job factors and unsafe acts and condition that affect the safety because of human attitude. Later a program is designed names Safety Awareness Program (SAP) by targeting the employees of various oil companies in Oman which will act as a moderating variable to know the impact of it at employee level such the work performance, individual performance is improved with results of accidents/fatalities in the industry. The detailed analysis shall be done by self-structured questionnaire.

Keywords: *accident theories; oil industry; safety awareness program.*

1. Introduction

From the annual reports of bench marked companies from 2016-2018, also from the case studies available approximate 100 disaster cases were analyzed and is known that the possible hazard during drilling are larger in number. The outcome indicates the change in control measures that is suggested in-order to have safe and healthy work environment at work place. Personnel working in the drilling rig have to be very disciplined and cautions during their working hours. Working at a drilling field requires sweat and patience, the amount of money and people at stake as oil and gas projects are usually very high and one mistake can cause a fortune. To make the study stronger several papers focusing on lesson learnt from disasters, accident causation models, behavior in anticipating the accidents in the industry with its root causes, inherent factors affecting the accident are taken into account.

Mostly accident don't just happen largely they are caused due to unsafe acts or due to unsafe conditions or combination (Choudhry et al., 2011)[1] (US Chemical Safety Hazard and Investigation Board, 2010) [2] above 80% workplace accidents are linked to unsafe behavior (Mergs, 2015)[3] and every risk is associated with different criteria based on environment, based on nature of rock,..(Necci et al., 2019) [4] .Failure to ensure the barriers is one of the cause for disasters in hydrocarbon industry and in barrier failure process failure of human factors is the core element (Martin &Black, 2015) [5].The finding of the paper states that largely the fatalities and incidents is documented in South East Asian and Middle Eastern region at drilling sites. The paper brings an idea that technical issues can be resolved at field only when sufficient technology (software) is available (Asad, 2019) [6].

Every year many drilling crews face challenging and life-threatening situation due to safety concerns and health at sites (drilling). Therefore, drilling operations is considered to be thrice dangerous than construction and twice risky than other general industries. (Asad, 2019) [6]. The research findings gave various issues of the accidents and injuries at workplace. The future studies recommended that it must consider investigating data methods such as behavioral observation. The other mediating elements such as emotional exhaustion, skills, motivation and work pressure, could be considered which strengthen the results.(Liu et al., 2020) [7]

The accident pattern occurrence in hydrocarbon industry against the different patterns are most followed in many organizations. Heinrich conception of causation of accident theory that may be relevant for other industries but not for hydrocarbon industry. Therefore, no such evidence from primary survey and from literature states that

Heinrich conception of causation of accident theory is ruled out in hydrocarbon industry. Ali Hasan and Al-Shanini [8] states in process industries domino theory describes accident sequence as chain of five elements or factors (unsafe acts or conditions, fault of person, accident or injury, social and environmental) if one factor falls, the other four factors would surely fall. Human failure is one considered factor.

The research work done by tong is to analyze the connection between safety participation and compliance related to safety with the role of job plays and unsafe behavior, which is ample evidence showed the importance among workers in process companies or industries. The results shown that oil workers' that there is decrease in unsafe behavior with contribution of safety compliance and participation. However, psychological condition was confirmed as moderator which helps in mitigation. Hence, suggested that psychological conditions of employees and related factors must be taken into account in order to reduce unsafe behavior (Tong et al., 2020) [9].(Ehiaguina & Moda, 2020)[10] stated poor safety culture at work place is one of the major factors that has an impact on employee's safety behavior at work place, which might directly result in accidents or injuries and helps in strengthening the culture which can improve performance of safety

To determine the influence of safety of the employees' and its impact on health and safety submission within local industry a survey on safety culture shall be online which targets the workers within industry of frontline which covers most subject like procedure followed for ensuring safety communication and its resultant influence on employees' behavior, training needs and employee safety commitment.

1.1 Statement of the problem

Oil and Gas Industry is exposed for low probability and has high impact on accidents. However good (HEMS) Health, Safety, Environmental management systems in place, knowing the risk before planning for drilling, knowing the risk location during drilling, human factors at work place are ruling the prevention of accidents. However, it is not always similar in most of the cases. According to WOAD database in last few decades approximately 6000 accidents have taken place only in offshore. The attempt has been made in recording the accidents took place from 2016-2019 and in knowing their causes. When you use the repeated disasters taking place it gives a sign of alarm of failure in safety management to ensure proper barrier in place is the common root cause. Inadequate training, lack of supervision and competence are the reasons are failure to finding the hazards and risk assessment. The recent trends show that most of the accidents take place in oil industry are largely in drilling, production domain.
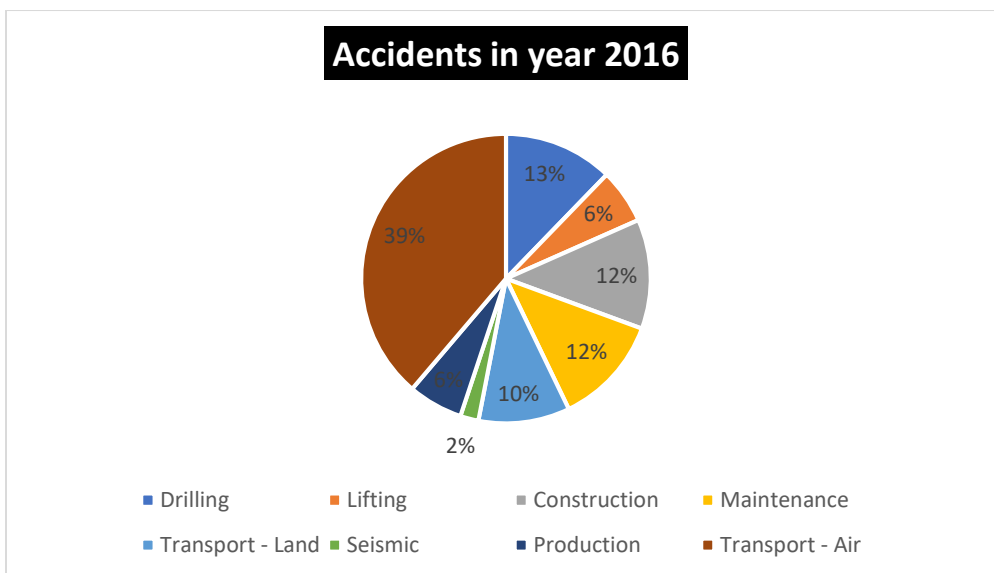

Figure 1: Accidents in domain area in 2016 (Source: IOGP bench mark report)
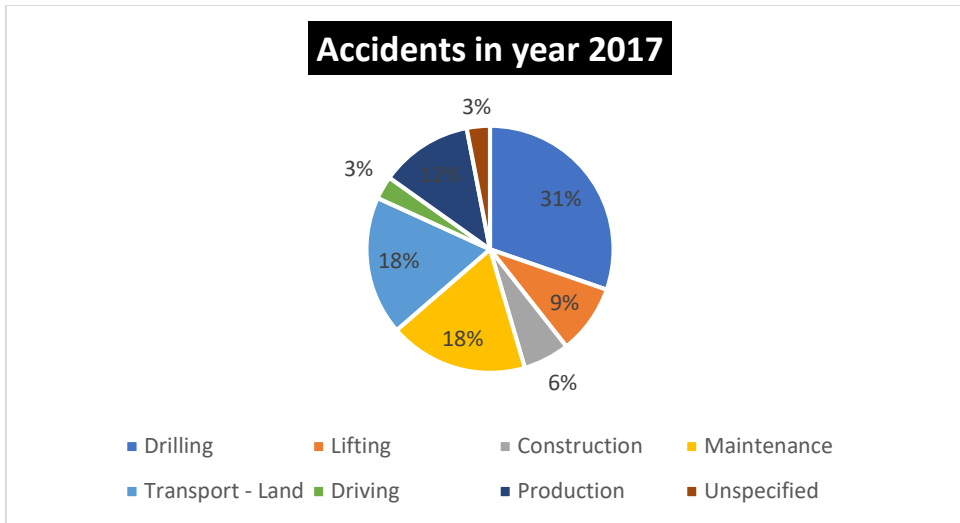
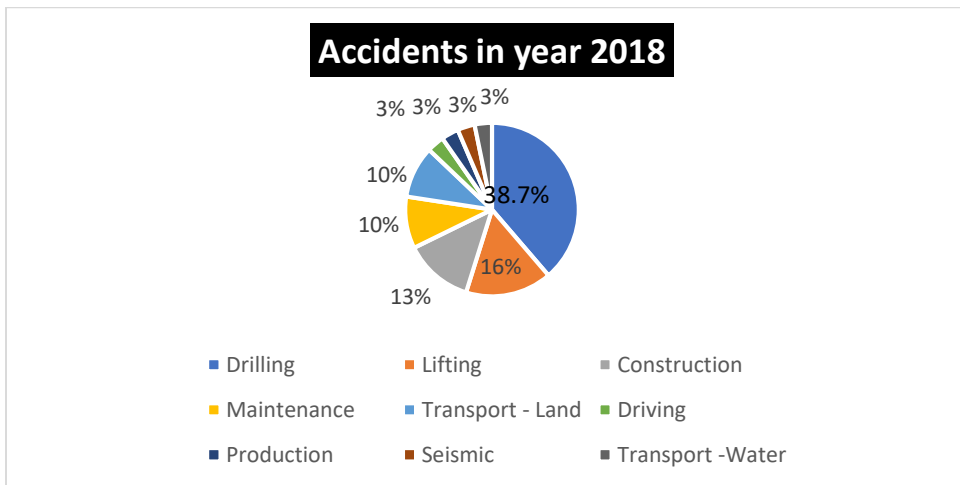Figure 2: Accidents in domain area in 2017 (Source: IOGP bench mark report) [12]

Figure 3: Accidents in domain area in 2018 (Source: IOGP bench mark report) [13]

If we see the above graph most of the accidents in Oil and Gas Industry are in upstream largely related to drilling. To minimize the accidents an attempt to give the training is made at employee level and also to remove the technical barrier So a software shall be made which helps in calculating the various parameters that is directly linked to drilling which will help the engineer to do the drilling in safer and in healthy way.

The research study based on finding the reasons of occurrence of accidents, finding the proper barrier system available, accident analysis techniques implemented, various risk assessment techniques incorporated, how human attitude behaves at workplace in avoiding the accidents and attempt to make a software by which technical challenges can be overcome shall be addressed.

1.2 Significance of the study

Hydrocarbon plays a major role in growth of any country. According to report issued by (MOG) Ministry of Oil and Gas indicated that Sultanate of Oman daily crude oil production and condensate during March 2020 touched 1,078,475 barrels and increased by approximately 12.83% in comparison to Feb 2020. It has drilled approximately 700 wells till date. The database for the year 2019 is over 3.6 billion work hours reported in hydrocarbon sector (IOGP annual report). It clearly shows the growth in engagement of workforce and business which is directly linked to injuries at work place.

Example of Few disasters occurred in Oil and Gas Industry in worldwide Viz In year 1988 Piper Alpha, North Sea, where in 167 people lost their lives (Source: Offshore Technology), BHN disaster of ONGC wherein 22 personnel lost their lives (Source: Offshore Drilling, Accident and Incident), Kuwiat Oil field Fires in year 1992

(**Source:** ISBN: 970-0-08-042418-7), Disaster of Deep water horizon, Macondo well incident in year 2010 which caused significant environmental damage etc (Source: Environmental Protection Agency, USA), in march 2013 workers employed by Construction Company in Oman at Safah Oil field approximately 4 people died in accident, about 370-km away Muscat (north-west) due accident in oil field and very recently On May 27, the village of Baghjan in Assam suffered a blowout (an uncontrolled oil and gas spill) that occurred due to failing pressure systems in an oil well run by state-owned Oil India Limited (OIL) (**Source:** The Sawaddle),etc are the triggers to re-verify the accident patterns and understand its causations of accident. The intensity to identify the root causes and actions to close every single week linkage helps the Oil and Gas Industry for accidents prevention. The rise in Oil & Gas disasters in Pipeline explosion, fire, oil spills, blow out, kicks at many oil fields is a symptom to understand the pattern of accidents and propose control mechanisms.

Over last few years, the technology is quickly changing along with automation taking place for improved productivity along with controls measures, consequently newer risks influxes into activities at work place and when the controls fail accidents are largely caused. However, the oil and gas industry reacts to many major incidents/accident that has triggered to environmental, human loss or property damage and on other side the industry is failing to know, understand or learn lessons to prevent the accident from occurring again. This would result in recognizing the failures of the controls of safety management and behavior of personnel at the site. Failure in recognizing the hazards, risk behaviors, root causes of accidents and pattern of knowing the accident is very important.

Twenty five safety awareness surveys of various organizations (petroleum and non-petroleum industries) reveals the awareness level of safety (on accident occurring pattern) among, ship-floor personnel. Hence scope of about 25-30% is there in improvement related to safety awareness of employees. 80-90% of accidents are caused largely by or due to unsafe acts or behaviours.

The research finding from this study will significantly be beneficial for all level of employees in the organization. The practice of assessment of an individual risk factor wills not only provides technical insights but also improves the behaviour (psychological and emotional) which will have a significant effect on their day to day responsibilities at work.

2. Literature Review

Theoretical literature shall be reviewed which gives a strong foundation on various concepts. Literature helps to get acquainted with research problems and may also provide guidelines in selection of best research approach.

The research would go through in following scale:

2.1 Lesson learn from disasters

(Mergs, 2015)[2] mentioned in research that above 80% workplace accidents are linked to unsafe behavior and every risk is associated with different criteria based on environment, based on nature of rock,..(Necci et al., 2019) [14]. The reason is not clear always the reason what and why it is measured. There are various terms which creates a confusion among practitioners and researchers. (**Source:** Environmental Protection Agency, USA are: use of six centralizers instead of twenty-one, (Hopkins, 2012; NCBP, 2011)[15]. Jain &Yerramilli (2012)[16] in his research paper explained about major blow out that took place in Krishna Godavari basin which caused in innumerous risks in linking to loss of human lives, material and environment pollution because to the heterogeneity of subsurface geology complexity for the wells. Failure to ensure the barriers is one of the cause for disasters in hydrocarbon industry and in barrier failure process failure of human factors is the core element (Martin &Black, 2015) [17]. Every year many drilling crews face challenging and life threatening situation due to safety concerns and health at sites (drilling). Therefore, drilling operations is considered to be thrice dangerous than construction and twice risky than other general industries. The paper brings an idea that technical issues can be resolved at field only when sufficient technology (software) is available (Asad, 2019) [18].

2.2 Occurrence of accident, prevention models

The research findings gave various issues of the accidents and injuries at workplace in hazardous industry which is expected as complex which demanded the need of qualitative measures which helps in problem of practical nature. The results shall be more accurate if the database of injuries and accidents shall be considered in analysis. Unfortunate such database is practically difficult to access and might be possible theoretically. The future studies recommended that it must consider investigating data methods such as behavioral observation. The other mediating elements such as emotional exhaustion, skills, motivation and work pressure, could be considered which strengthen the results.(Liu et al., 2020) [19]. The main drawback is people/organization doesn't take the age and experience into

account while evaluating the risk. The operational risk having crucial tasks, especially during drilling actions (Abimbola et al., 2016[20]) limit to only risk categories like organizational risk, security risk, natural risk and technical risk.

2.3 Behavior and attitude of individual in prevention of accidents

The research work done by tong is to analyze the connection between safety participation and compliance related to safety with the role of job plays and unsafe behavior, which is ample evidence showed the importance among workers in process companies or industries. The results shown that oil workers' that there is decrease in unsafe behavior with contribution of safety compliance and participation. However, psychological condition was confirmed as moderator which helps in mitigation. Hence, suggested that psychological conditions of employees and related factors must be taken into account in order to reduce unsafe behavior (Tong et al., 2020) [21]. BBS systems train employees to look for the root causes of their accident-prone behavior and enables to recognize behavioral trends that cause them to get involved in safety accidents/incidents. It transfers control of the event into the hands of the employee so that the employee becomes proactive with regard to individual safety rather than a victim of environmental conditions (JasiulewiczKaczmarek et al., 2015).

2.4 Inherent factors affect accident

(Gordon, 1998) in his paper took human factors as (Individual Factors, Group Factors, Organization Factors) [22] (El Bouti & Allouch, 2018) in his paper took human factors as (Individual Factors, Group Factors, Organization Factors) [23]. (Galis et al., 2018)[24] states 'BBS training is required once in a year for the employees which in positive results because of their level of commitment and their knowledge which is directly seen in safety performance' but the limitation with it is BBS implementation in the company has financial issues, top management support seems a barrier at the top that obstructs BBS implementation [25]. (Zhang et al., 2019)the author focused largely on safety behavior improvement and the condition of mental health of employees. The evaluation is done by taking the results from two set of questionnaire in order to know the sustainability as a key factor in hydrocarbon industry. Further the author suggests the future researchers to develop human factors and other behavioral science approaches which helps in improving sustainable development along with safety performance in hydrocarbon industry [26].

2.5 Major theories of accident

Accident causation model is methodical method of determining the causes of accident. The coincidence of various activities which is complex in a single time and space is called as accident. Determination of causes leading to it is difficult since so many variables are involved in it.

In early 20th century the existence of systematic examination of causes of accidents has begun and development of it started with simple linear "domino model," which explains about behavior of an individual and situation surrounding the accident. Further the advancement of it to place too complex linear models and then to complex non-linear models keeping time factor in mind time. The development of various models is still on.

There are various theories of accident causation which are listed below:
a. Heinrich theory
b. Human Factor theory
c. Accident or Incident theory
d. Epidemiological theory
e. Systems theory
f. Behavior theory

a. Heinrich Theory:
This theory is dependent on five factors:
- Social Environment
- Persons Fault
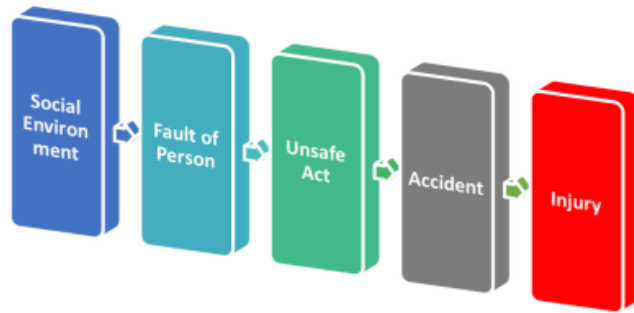- Unsafe act/mechanical or physical hazard
- Accident and
- Injury

Figure 4: Approach to accident/prevention – H W Heinrich

b. Human Factors Theory
According to this theory, basic cause of the accidents is human error. The main causes attributed are:
- Overloading
- The task of work assigned is outside the ability or capacity of the worker
- Noise and distractions caused due to factors of environment
- Personal problems and emotional stress due to international factors
- Unclear instructions and risk level due situation factors

c. Accident/Incident Theory
The This is an advancement of the human factors theory, the accident/incident theory of accident causation which introduces elements like overload, ergonomic traps and decision to err. This model is called Petersen's model. The concept of overload which is caused by capacity of which state or load is which is similar to (human factor theory) Ferrell's work. There are few changes do exist.
In general, this theory is divided into three:
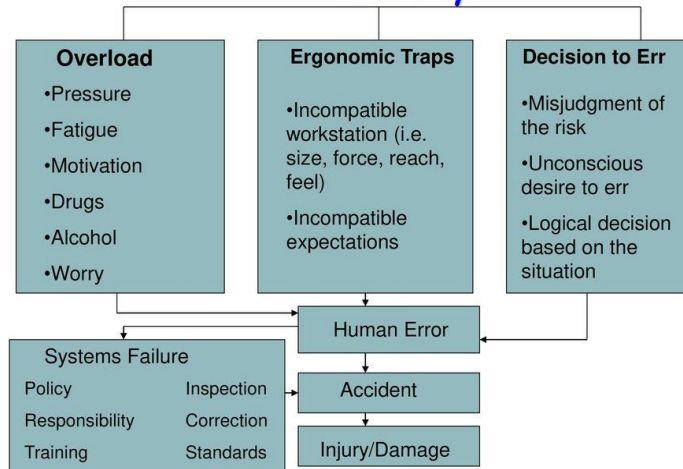- Overload
- Ergonomic Trap
- Decision to err

Figure 5: workflow of accident or incident theory

d. Behavior based theory

Referred as behavior based safety (BBS). IT consists of 7 basic principles

- Intervention/Interference/Meditation
- Internal factors identification
- Motivation to behave in the desired manner
- Focus on the positive consequence of appropriate behavior
- Scientific method application
- Information integration
- Intervention planned

2.6 Proposed Conceptual framework

The conceptual framework will go in stage as mentioned below:

STAGE 1:
- Identifying the accident pattern from 2016-2019/20 (major locations) and finding the accident pattern and check whether Heinrich Causation model/safety pyramid.

STAGE 2:
- Identifying the accident pattern from 2016-2019/20 in Green Valley and finding the accident pattern (major locations) and check whether Heinrich Causation model/safety pyramid.
- Risk Management Plan/ Risk Register is prepared in line with FINE & KINNEY METHOD

STAGE 3:
- Preparing the Questionnaire on three variables (Personal Factors, Job Factors, Unsafe Acts and Unsafe Condition) have an impact on human attitude (safety) keeping moderating variable as Safety Awareness Program (SAP).
- Based on the various analysis and its significance, effect of demographic variable on these factors shall be known.

STAGE 4:
- Study of various accident cause analysis methods and propose the best method, Attitude barrier model (ABM) – Risk Matrix (Age, Experience, Work Conditions and Elements of Fatigue)

STAGE 5:
- Developing software on visual studio for Oil Well Drilling to minimize the risks in field (Technical).
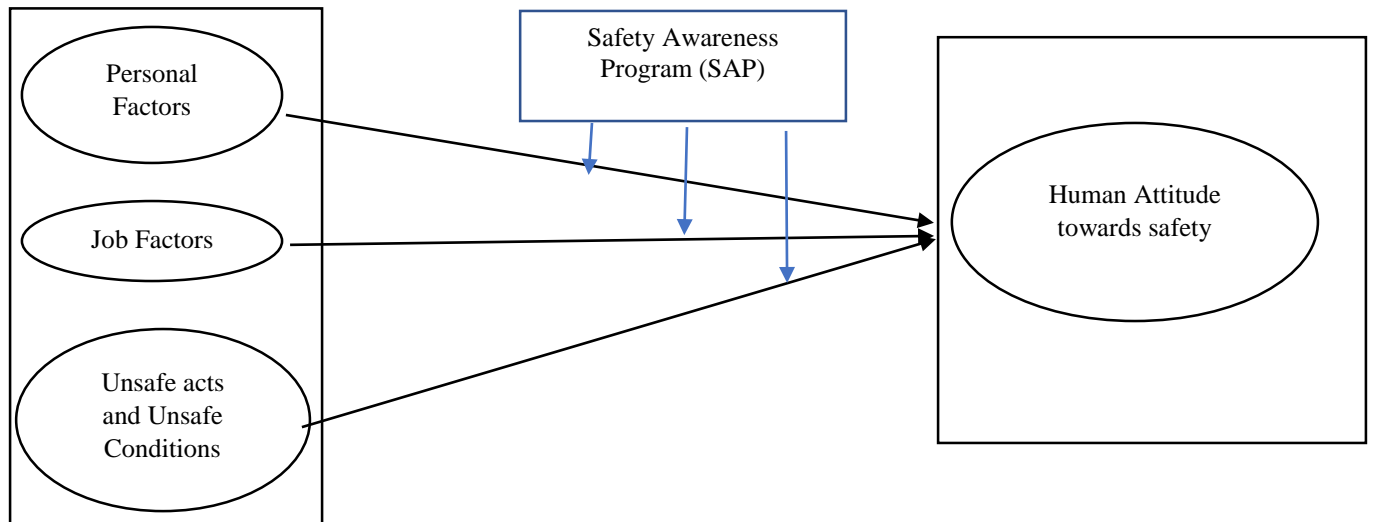

Figure 6: Conceptual framework of stage 3

Better understanding of various factors that affect the human attitude towards is the general purpose of study. The impact of it is done by moderating variable safety training. Resulting from such objective related to BBS, the following research hypothesis are developed and are proposed to be tested. Research hypothesis is a hypothetical statement of relationship between two or more variables. It is testable having tentative problem to the relationship

between those variables that create. The assumptions made in order to arrive at the Hypothesis of the research are as follows:

H (1): There is a positive impact and significant correlation between personal factors and human attitude towards safety

H (2): There is a positive impact and significant correlation between job factors and human attitude towards safety

H (3): There is a positive impact and significant correlation between unsafe & unsafe conditions and human attitude towards safety

H (4): Influence of Safety awareness program on relationship between Personal Factors and human attitude

H (5): Influence of Safety awareness program on relationship between Job Factors and human attitude

H (6): Influence of Safety awareness program on relationship between Unsafe and Unsafe Conditions and human attitude

In the framework, Human attitude towards safety is influenced by personal factors, job factors, unsafe and unsafe conditions. The figure above shows the significant relationship between influencing factors of each.

3.Proposed Research Methods
3.1 *Population and sample*
The data is collected from a particular population group and in this research, the oil industry employees are largely focused. Population usually refers to group of people in total which depends on interest what investigation is to be done by the researcher (Sekaran & Bougie, 2013). The population of this study is the employees of oil companies in Oman different levels of experiences and their roles. It includes the combination of junior and manager levels people to be interviewed for the variables and human performance indicators. A, B, C, D and E with the help of Green Valley and Trading LLC in Oman.

Sample size determination is very important phase in sampling process. The sample size referred to as the measuring of target population samples (van Smeden, et.al, 2019). The sample size of this study is a total between 300-350 participants to get the meaningful outcome. Another questionnaire is made to find the inherent factors (human attitude effect safety at work place) that affect the work place and analysis will help in knowing the lapses at operational/work place with the help of mediating variable as (SAP) safety awareness program.

3.2 *Data Collection:*
Primary data is collected by a set of self-structured questionnaire in information from the employee working in various companies are gathered. This technique helped in understanding the awareness and behavior of the people. Secondary data is collected from internet, books, company reports, journals. In this research both primary and secondary data collection method is used. The survey questionnaire will be utilized with the help of 5-point Likert scale close-ended questions to gather their opinions.

3.3 *Data Analysis*
The statistical analysis is explained as the analysis of gathered data. The purpose of analysis if the data is to get out good information and to make the decision the responses of employees working in oil companies has been analyzed by entering the data initially in SPSS software. Further, it has been analyzed by implementing reliability analysis (Cronbach alpha), frequency analysis, correlation analysis, and multiple linear regression.

4. Conclusion and Recommendations:
The conclusion of this paper has been reached to the vitality of conducting an in-depth research to proposing a new multi-theoretical framework which consists of Domino theory, accident or incident theory and behavior based theory. The occurrence of accident pattern in Oil & Gas industry is to be considered otherwise than traditional accident occurrence theories if barrier model is not developed along with detailed risk register is not made. Largely the causes of accident in hydrocarbon industry is due to failure of barriers which are primarily related to human behavior. The Inherent human factors which influence accidents, largely includes unpredictable work pattern – rotations shift pattern, overload of work, fatigue, stress, living conditions, pay cuts during recession, working offshore condition, physical condition at work place. Lack of job security (career prospects and reward), lack of training prospects, change in business, which was not the case before, and courses on safety training since employee are not updated with time enough are also some of the other factors which influence the accidents. By ensuring the proper care is taken on above the parameters mentioned can improve safety performance at work place. The analysis on SPSS shall give a broader image about the impact of training at employee level, also no standalone software is available in industry which can do the calculations real-time of multiple things related to drilling so attempt is made to design the same.

References

1. Masood, R., & Choudhry, R. M. (2011). Measuring Safety Climate to Enhance Safety Culture in the Construction Industry of Pakistan. *CIB W99 International Conference on Prevention: Means to the End of Injuries, Illnesses, and Fatalities, August 24-26*, *54*(2002), 1243–1249. http://www.irbnet.de/daten/iconda/CIB_DC24434.pdf

2. US Chemical Safety Hazard and Investigation Board. (2010). Us C H E M I C a L S a F E T Y a N D H Az a R D I N V E S T I G a T I O N B O a R D Investigation Report Volume 1. Explosion and Fire at the Macondo Well, 1(Investigatin Report), 1–37.

3. Mergs, M. A. (2015). BEHAVIOURAL SAFETY AND MAJOR ACCIDENT HAZARDS : MAGIC BULLET OR SHOT IN THE DARK ?

4. Necci, A., Tarantola, S., Vamanu, B., Krausmann, E., & Ponte, L. (2019). Lessons learned from offshore oil and gas incidents in the Arctic and other ice-prone seas Lessons learned from offshore oil and gas incidents in the Arctic and other ice-prone seas. Ocean Engineering, 185(August), 12–26. https://doi.org/10.1016/j.oceaneng.2019.05.021

5. Martin, D., & Black, A. (2015). Preventing Serious Injuries and Fatalities: Study Reveals Precursors and Paradigms. Professional Safety, 60(09), 35–43.

6. Asad, M. M. (2019). Oil and Gas Disasters and Industrial Hazards Associated with Drilling Operation : An Extensive Literature Review. 2019 2nd International Conference on Computing, Mathematics and Engineering Technologies (ICoMET), March, 1–6. https://doi.org/10.1109/ICOMET.2019.8673516

7. Liu, S., Nkrumah, E. N. K., Akoto, L. S., Gyabeng, E., & Nkrumah, E. (2020). The State of Occupational Health and Safety Management Frameworks (OHSMF) and Occupational Injuries and Accidents in the Ghanaian Oil and Gas Industry: Assessing the Mediating Role of Safety Knowledge. BioMed Research International, 2020. https://doi.org/10.1155/2020/6354895

8. Ali Al Hasan Al-Shanini. Arshad Ahamad, Faisal Khan 2014. Accident modelling and analysis in process industried, Journal of Loss prevention in the process industries,

9. Tong, R., Yang, X., Parker, T., Zhang, B., & Wang, Q. (2020). Journal of Loss Prevention in the Process Industries Exploration of relationships between safety performance and unsafe behavior in the Chinese oil industry. Journal of Loss Prevention in the Process Industries, 66(May), 104167. https://doi.org/10.1016/j.jlp.2020.104167

10. Ehiaguina, E., & Moda, H. (2020). Improving the Safety Performance of Workers by Assessing the Impact of Safety Culture on Workers ' Safety Behaviour in Nigeria Oil and Gas Industry : A Pilot Study in the Niger Delta Region. 14(6), 152–156.

11. IOGP report for year 2016

12. IOGP report for year 2017

13. IOGP report for year 2018

14. Necci, A., Tarantola, S., Vamanu, B., Krausmann, E., & Ponte, L. (2019). Lessons learned from offshore oil and gas incidents in the Arctic and other ice-prone seas Lessons learned from offshore oil and gas incidents in the Arctic and other ice-prone seas. Ocean Engineering, 185(August), 12–26. https://doi.org/10.1016/j.oceaneng.2019.05.021

15. Hopkins, A., 2012. Disastrous Decisions: The Human and Organisational Causes of the Gulf of Mexico Blowout. CCH Australia, Sydney.

16. C.K.Jain, S.S.Yerramilli, R.C. Yerramilli. A Case Study on Blowout and its Control in Krishna-Godavari (KG) Basin, East Coast of India: Safety

17. Martin, D., & Black, A. (2015). Preventing Serious Injuries and Fatalities: Study Reveals Precursors and Paradigms. Professional Safety, 60(09), 35–43.

18. Asad, M. M. (2019). Oil and Gas Disasters and Industrial Hazards Associated with Drilling Operation : An Extensive Literature Review. 2019 2nd International Conference on Computing, Mathematics and Engineering Technologies (ICoMET), March, 1–6. https://doi.org/10.1109/ICOMET.2019.8673516

19. Liu, S., Nkrumah, E. N. K., Akoto, L. S., Gyabeng, E., & Nkrumah, E. (2020). The State of Occupational Health and Safety Management Frameworks (OHSMF) and Occupational Injuries and Accidents in the Ghanaian Oil and Gas Industry: Assessing the Mediating Role of Safety Knowledge. BioMed Research International, 2020. https://doi.org/10.1155/2020/6354895

20. Abimbola, M., Khan, F., 2016. Development of an integrated tool for risk analysis of drilling operations. Process Saf. Environ. Prot. 102, 421–430.

21. Tong, R., Yang, X., Parker, T., Zhang, B., & Wang, Q. (2020). Journal of Loss Prevention in the Process Industries Exploration of relationships between safety performance and unsafe behavior in the Chinese oil

industry. Journal of Loss Prevention in the Process Industries, 66(May), 104167. https://doi.org/10.1016/j.jlp.2020.104167

22. Gordon, R. P. E. (1998). The contribution of human factors to accidents in the offshore oil industry. *Reliability Engineering and System Safety*, *61*(1–2), 95–108. https://doi.org/10.1016/S0951-8320(98)80003-3

23. El Bouti, M. Y., & Allouch, M. (2018). Analysis of 801 Work-Related Incidents in the Oil and Gas Industry That Occurred Between 2014 and 2016 in 6 Regions. *Energy and Environment Research*, *8*(1), 32. https://doi.org/10.5539/eer.v8n1p32

24. Galis, A. A., Hashim, N., Ismail, F., & Yusuwan, N. M. (2018). The factors affecting Behaviour Based Safety (BBS) implementation in oil and gas industry. *International Journal of Engineering and Technology(UAE)*, *7*(3), 157–161. https://doi.org/10.14419/ijet.v7i3.11.15952

25. Galis, A. A., Hashim, N., Ismail, F., & Yusuwan, N. M. (2018). The factors affecting Behaviour Based Safety (BBS) implementation in oil and gas industry. *International Journal of Engineering and Technology(UAE)*, *7*(3), 157–161. https://doi.org/10.14419/ijet.v7i3.11.1595225.

26. Zhang, J., Chen, X., & Sun, Q. (2019). A safety performance assessment framework for the petroleum industry's sustainable development based on FAHP-FCE and human factors. *Sustainability (Switzerland)*, *11*(13). https://doi.org/10.3390/su11133564