EXECUTIVE SUMMARY

Petroleum Industry is the backbone for any country’s economic development and social strength. However, Oil & Gas Exploration, Production and Pipeline transportation are involved with high risk activities. The accidents occurred or continued to occur in the industry had a significant impact on personnel, environment or assets.

Operations of Oil and Gas facilities are exposed to greater risks involving personnel, environment and property. Low frequency and high impact incidents have caused significant human loss in the industry. The accidents caused in Oil and Gas Industry resulted in significant human loss. Human errors are the major root causes of any industrial accidents. It is also truly applicable to Oil & Gas Industry. Unsafe practices such as unsafe conditions and unsafe acts are basic causes of most accidents.

Over the recent years, technology is rapidly changing and automation is taking place for better controls, better productivity. Accordingly, newer risks influxes into work place activities and when controls fail accidents are caused.

The crisis of current low Oil prices is another dimension of increasing threat of environmental incidents, workplace injuries resulting in human loss due to forced cost cutting on Oil and Gas operations. Experience has demonstrated that ‘cost cutting’ can result in undesirable reductions in the protections that are needed to be ‘safe’. More than 350,000 people laid off in the oil and gas industry worldwide during 2014-2016.

“It is analogous to driving a car without a speedometer and being told and required to ‘drive safely’.”
However, the industry reacts to any major incident that has caused human loss and any environmental or property damage. It is failing to understand or learn lessons to prevent recurrence. This could be attributed to failure to recognize the safety management controls and personnel behaviours at work site, failure to recognize the hazards, at risk behaviours, root causes of the incidents and failure to understand the pattern of accidents. Now, many organizations are looking at changing from legislative compliance to positive proactive measures. In order to achieve these objectives, one has to focus on understanding the common root cause of the accidents pertinent to Oil & Gas Industry.

Therefore, further understanding the accident patterns and weak links in the process of accidents occurrence, evaluation of relevant models for mitigation of accidents could be a recognizable research in the field of Health, Safety & Environment.

Every accident is associated with different type of failures with different root causes. Repeated disasters are revealing that safety management failure to ensure proper barriers in place is the common root cause. For that effective safety programs which prevents the accidents should be in place to deliver the benefits in terms of tangible and intangibles. Good safety practices have to be recognized by employers and the contractors in prevention of accidents. It is the duty of the personnel working in the Oil and Gas sectors, to protect the personnel, environment and at the same time pursue the goal of economic development. Every life is equally important should be the theme.

Many accident occurring theories have evolved to give reasoning with its occurring and to understand the pattern. Also varieties of accident investigation models are in use to analyse the accident causes and accordingly propose recommendations to prevent reoccurrence.

Motivating from the above context, current research is focused on studying the patterns of accidents occurred in Oil and Gas fields, root causes of the
disasters, significant contributors for the accidents including human factors, attitudes, different work patterns, environmental conditions. Also the research verified that how the Oil and Gas Industry conceptualised the accident occurs, the relevance of existing accident models, influence of inherent human factors.

The scope of the research includes Oil and Gas Upstream activities viz. Exploration, Drilling, Production and transportation. The source of the sample data for the research is from benchmarking reports of International Oil & Gas Producers (IOGP) and focused accident analysis reports of Cairn India Limited’s Oil & Gas assets located in India.

The Objectives of the current research are divided into five broad categories and are:

- Carry out Research in identifying the pattern of accidents occurred in Oil and Gas facilities.
- Compare the accident causations of Cairn India with Other accident causation models to identify similarities or gaps.
- Study the inherent risk factor including human attitudes that are contributing to accident in Oil and gas exploration and production facilities.
- Study the current methodologies of accident root cause analysis that the Oil and Gas Industry adopted and suggest improved method.
- Suggest Recommendations

The methodologies for the research work adopted are survey research, review of disasters occurred in Oil & Gas Operations worldwide, review of accident
causation models, suitability of various models and influence of inherent human attitudes in accident patterns.

From the benchmarking reports published by International Oil & Gas Producers (IOGP), during the year 2014 there was about 51% reduction in fatal accident rate. It is further reported that 78% of fatal accidents would have been averted by following lifesaving rules. These lifesaving rules are directly related to human attitudes and work place safety behaviours.

There are a number of common causal factors appeared consistently in the top ten for both fatal incidents and high potential events for each of the past five years.

- Organizational: Inadequate training/competence
- Inattention/lack of awareness: Improper decision making or lack of judgment
- Organizational: Inadequate work standards/ procedures
- Organizational: Inadequate supervision
- Organizational: Inadequate hazard identification or risk assessment.

A specific survey form has been designed objectively and circulated to field personnel of various parts of Oil & Gas Industry. More than 350 such feed backs have been received and analysed. The survey form composed of 15 elements covering the basic understanding of Heinrich theory of accident occurring, relevance to Oil & Gas, significance of root cause analysis, importance of safety barriers in prevention of accident occurring. Field safety personnel, line managers, group managers, contractor representatives, work site supervisors, graduate engineers have participated in the survey. The samples were obtained from Oil & Gas operations spread over in India, Aberdeen UK, Canada, Kuwait, Saudi Arabia, Qatar Petroleum, Bahrain and UAE.
The survey supported the current research with the following:

- All accidents are preventable
- Heinrich theory of accident occurring is not fully satisfying the causation of accident occurring in Oil & Gas.
- Barriers are very important in prevention of accident occurring.
- Failure to identify the hazards and ensuring risk controls are the cause of the accident occurring.
- Inadequate root cause analysis or lack of skills are the deficiencies in identifying the accident occurring.
- Attitude of work force is having direct relation to accident occurring.
- Behavioural changes may reduce the accidents.

The results of the research objective emerged with the following:

- Failure of safety barriers leading to disasters in Oil & Gas.
- Heinrich theory of accident occurring is not fully satisfying the causation of accident occurring in Oil & Gas
- Inadequate hazard identification, Job supervision and lack of competency are the causes for work place serious injuries.
- Behavioural safety and cultures is still the weakest link in accident occurring in Oil & Gas operations.
- Attitude of work force is having direct relation with accident occurring and behavioural changes may reduce the accidents.

The second research Objective is to “Compare the accident causations of Cairn India with Other accident causation models to identify similarities or gaps”.

More than 2500 accident cases have been analysed and compared with Heinrich theory of accident occurring. Focus was drawn on the influence of age factors, activity, types of injuries and experience of the personnel.
The results of the said objective are as follows:

- The patterns suggested by Heinrich is not accurately justifying the patterns of accidents that are occurring in Oil & Gas industry.
- Personnel between age group of 20-30 years in Cairn India are found to be more in work place injury exposure.
- Caught between, dropped objects, slip/trip and fall are similar in Carin India E&P activities when compared with other similar companies.
- More serious injuries are resulting from Drilling activity in Cairn compared to others.

The results of third objective “Study the inherent risk factor including human attitudes that are contributing for accident in Oil and gas exploration and production industry” are:

Organisations with the best and consistent safety culture identified the human attitudes are the key component of accident occurrence. A field research work was carried out designing a program which included Personal factors, Job factors, Unsafe Acts, Unsafe Conditions, Personnel Protective Equipment and Tools & Equipment. More than 1000 personnel were trained in identifying the basic hazards at work place, at-risk behaviours of the personnel and other factors. The program was tested for Cairn India’s Up-stream Oil and Gas facilities for a period of three years. The output of the Observations was analysed. The results of the research found to be:

- Personal attitudes are directly related to accidents.
- Failure to recognize the hazards causing the accidents.
- Consistent Behavioural interventions preventing the work place injuries.
- Near misses are significant part of accident occurring.
- Recognizing the nearmises, analysing the root causes and preventing the reoccurrence contributes to reduction of accident.
The illustration and results of fourth objective “Study the current methodologies of accident root cause analysis that the Oil and Gas Industry adopted and suggest improved method” are:

Oil and Gas currently uses various accident analysis techniques and methods to identify the root causes.

Root cause analysis (RCA) is one of the technique widely used in Oil and Gas Operations. It is a process designed for use in investigating and categorizing the root causes of events with safety, health, environmental, quality, reliability and production impacts.

The other techniques are 5 Whys analysis techniques. It is using 5 Whys which doesn’t always lead to root cause identification when the cause is unknown. That is, if the cause is unknown to the person doing the problem solving, using 5 Whys may not lead to any meaningful answers.

This technique depends on to some degree contingent upon the skill with which the method is applied; if even one Why has a meaningless answer, the whole procedure does not yield the result. It is also not dependency of repeatability. If three different personnel applying 5 whys to the same problem may come up with totally different answers. It is also having limitation in distinguishing between causal factors and root causes.

Bow-tie analysis is a visual tool gives the effectiveness of barriers preventing a top event resulting from a hazard. The analysis depends upon the skill of the personnel performing the analysis. During the current research work this is widely used and inferred that this technique is giving opportunity to identify the barrier failures. The focus of this technique is driving from the ways the release of inherent hazard leading to a top event when designed barriers fail. Also the recovery mechanism of the incident release and the effectiveness of the barriers helping the investigator. From the literature survey it is interpreted that bow-tie method of accident analysis is a structured assessment and
communication of risks and clearly demonstrates the link between control measures and management system arrangements. It can be used to qualitatively assess and demonstrate control of all types of risks. However, it further needs inputs of the individual carrying out the analysis.

Fish-bone analysis, a cause and effect diagram, often called a “fishbone” diagram to identify possible causes of a problem and in sorting ideas into useful categories. A fishbone diagram is a visual way to look at cause and effect. However, the success of this technique depends on the knowledge and skills of the analyst.

Swiss cheese Model is an understanding of accident causation.

It links human systems to multiple slices of Swiss cheese, stacked side by side, in which the risk of a threat becoming a reality is mitigated by the differing layers and types of defence which are "layered” behind each other. Therefore in theory, lapses and weaknesses in one defence do not allow a risk to materialize, since other defences also exist, to prevent a single point of weakness. It is having limitation of integration with other mathematical models.

Barrier based Systematic Cause Analysis Technique (BSCAT) is a method that links modern risk–based safety management approaches to systematic root cause incident investigation. The model is a sequence of dominos establishing the hierarchy of accident progressions of the immediate cause back to fundamental root causes and system failures.

The current research work has extensively used the BSCAT technique to analyze the root causes of various incidents of Oil & Gas. It is inferred that it is providing an opportunity for analyzing the root causes in more structured way.
The results of this objective are:

- To identify root causes of an incident many analytical tools are available. Each tool is having its own limitations.
- These tools often fail to provide the true underlying causes.
- These advanced tools depend on the specialist’s judgment doing the analysis.
- Failure of human factor quotients to be considered in analysing the accidents.
- The Attitude Barrier Model is useful in analysing of major accident in respect to contribution of human factor.
- Human factor are related to major hazard accident.

- The fifth Objective of this research work is to propose recommendations based on the outcome of the analysis for better understanding the accident occurring in Oil & Gas Operations.

These recommendations are:

- Recognize that Oil & Gas Industry accident patterns are different compared to other industries.
- Oil & Gas Management to focus on inherent safety.
- Importance to be given to identification of hazards, Safety barriers and human factor
- Oil & Gas industries to evaluate specific safety promotional programs addressing, Consistent Behavioural interventions to prevent the work place injuries.
- Near miss are significant part of accident occurring.
- Oil & Gas Industry to recognizing that nearmis incidents are part of accident occurring. Therefore, emphasis to be given to analyse.
- Oil & Gas Industry to design Behavioural intervention programs specific to their activities.
- Industry may adopt the Attitude Barrier Model (ABM) while evaluating the root causes.
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➤ Industry to promote safety culture of identifying the human factors as core component of major hazard accident.

The literary contributions from the current research are:

➤ Carried out in-depth study of accidents that have occurred in Oil & Gas (Upstream). Verified the relevance and interpretation of Heinrich theory of accident occurrence in Oil and Gas (upstream).

➤ Influence of critical factor like age of personnel, shift patterns, hazard identification, risk controls in accident occurring.

➤ Details study was carried out for the serious accidents occurred at Cairn India an Oil and Gas (Up-stream) and identified specific gaps in their safety systems.

➤ Detail study of various accident causation and accident investigation models. Proposed a new model of accident occurring involving human factor.

➤ Study the inherent risk factor including human attitudes that are contributing for accident in Oil and gas exploration and production industry.

Following advantages is expected from the implementation of research recommendations.

➤ Human factors are directly related to major disaster in Oil & Gas (Upstream) operations. Therefore, if the Organisations incorporate the mitigation methods there would be significant life savings through prevention of accident.

➤ Though Heinrich theory illustrating the accident occurring, Upstream Oil and Gas to interpret further more inherent risk factors of human behaviours. The accident occurring ratios is different for Oil and Gas operations from Other Industry.

➤ The suggested model of accident occurring is having specific advantage for Oil and Gas (Upstream) in prevention of accidents. It is providing an
Opportunity for predicting the accident occurrence especially the inherent factors like influence of person’s age, experience and other working conditions.

Thus the research concludes with the solution to address the inherent human factors, hazard identification, effect and correction of at-risk behaviours in accident patterns of Oil and Gas (Up-stream).