CHAPTER 1.
INTRODUCTION

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.

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 for Oil & Gas Industry. Unsafe practices such as unsafe conditions and unsafe acts are basic causes of most accidents. Frank Bird’s accident causation theory which was accepted worldwide describes that there are number of underlining causes for any accident to occur. Scientific analysis and interpretation of root causes of accidents reveals that human errors are the weakest link.

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

However, the industry reacts for 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 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.

1.1. GENERAL

Exploration of energy resources has played an important role in generating and sustaining individual development and economic growth. The consequences (Anon, 1995) of increased use of these hydrocarbons resulted in environmental degradation and other potential hazards including the danger of loss of human life and property damage.

Operations of Oil and Gas Industry are exposed to greater risks involving personnel, environment and property. Low frequency and high impact incidents have caused significant human loss in the industry. However, every accident is associated with different type of failures with different root causes. Repeated disasters are revelling that safety management failure to ensure proper barriers in place is the common root cause. If the industry is educated with the pattern of accidents and occurrence of incidents with root causes, it can act proactively to prevent human loss or damages. 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 sector, 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.

The Oil and Gas Industry had witnessed and continue to witness the disasters viz. Piper alpha the world’s worst Oil & Gas disaster where in 164 people
have lost their lives and Deepwater Horizon[15], resulting in explosions and fire on the rig. Eleven people lost their lives, and 17 others were injured followed by Oil spill of International significance. Bombay High North (BHN) platform disaster resulted in loss of 22 lives and operational asset loss.

The industry has adopted accident occurring theories proposed by various authors. However, understanding the accident causation is the significant on its prevention.

There are linear models which suggest one factor leads to next and to the next leading up to the accident and there are complex nonlinear models which hypothesis multiple factors are acting concurrently and by their combined influence, lead to accident occurrences.

Incidents have been defined as an undesired event that has caused or could have potentially caused personal injury, illness and / or damage (loss) to assets, production or harm to environment or company reputation.

1.2. MOTIVATION FOR RESEARCH

The hydrocarbon sector plays vital role in the economic growth of the country. India has total reserves of 775 million metric tons of crude oil and 1074 billion cubic meters of natural gas.

The total number of exploratory and development wells and meterage drilled in onshore and offshore areas are 381 and 888 thousand meters respectively. Crude oil production during 2014-15 is 770 BBL/D//1K (Source: Trading Economics and reported by U.S Energy Information and Administration)

The refining capacity in the country increased to 177.97 million tons per annum (MTPA)

The number of million man-hours worked (including contract employees) in petroleum industry reached 4500 in 2014 (Ref: International Oil and Gas Economics)
Producers annual report). It indicates the growth in the business and the engagement of workforce which is directly related to the risk of work place injuries.

The disasters occurred in Oil and Gas Industry in worldwide Viz Piper Alpha, North Sea, where in 164 personnel lost their lives, BHN disaster of ONGC wherein 22 personnel lost their lives, Disaster of Deep water horizon, Macondo well incident which caused significant environmental damage etc., are the triggers to re-verify the accident patterns and understand the accident causations. The depth of identifying the root causes and actions to close every single week link helps the Oil and Gas Industry to prevent accidents. The rise in Oil & Gas disasters in India including Pipeline explosion and fire at Andhra Pradesh, Jaipur Oil terminal fire, Hazira terminal fire incidents are warning symptoms to understand the pattern of accidents and propose control mechanisms.

The researcher is having 29 years of industry experience in Health and Safety domain and experienced in safety management systems and leadership role. Further he is having exposure to accident prevention programs and investigation of various accidents and proposing the recommendations. He is also having a credit of six paper presentations on various Health and Safety issues nationally and internationally. Therefore self-motivation is an added value to the proposed research.

Twenty five safety awareness surveys of various organizations (petroleum and non-petroleum industries) in various locations in India reveal that the level of safety awareness (on accident occurring pattern) among managers is within the range of 75-85% and among the shop-floor personnel it is within the range of 70-80%. Hence there is a scope of nearly 25-30% improvement in safety awareness level of employees. Eighty to ninety percent of accidents are triggered by unsafe acts or behaviours. Thus, there is a need to further understand about specific causes of accidents pertinent to Oil and Gas fields.
1.3 RESEARCH SCOPE

The scope of the current research is “study of accident patterns in Oil and gas industry (upstream) and Verification with accident causation models. It is to verify the accident occurring patterns in Upstream including human factors, interpretation of accident causation models, testing of various existing models, interpretation of accident root causes of Oil and Gas disasters.

Figure 1: Representation of Research work

The above figure is illustrating the overall concept of the research work and its outcome which includes the Hazards, barriers, human factors, accident and injury.
1.4 RESEARCH OBJECTIVE

The study is designed at every stage keeping in view of the following objective

1. To carry out research in identifying the pattern of accidents occurred in Oil and Gas fields.
2. Compare the accident causations of Cairn India with other accident causation models to identify similarities or gaps. The outcome will help the industry to focus on their accident prevention programs to prevent accidents.
3. To Study the inherent risks factors that are contributing for accidents in Oil and Gas Exploration and Production Industry.
4. To Study the current methodologies of accident root cause analysis that the Oil and Gas industry adopted and suggest improved method.
5. To suggest the recommendations to overcome the problem.
1.5 RESEARCH METHODOLOGY

1.5.1 Theoretical framework –

There are several major theories concerning accident causation [31], each of which has some explanatory and predictive value. Oil & Gas industry also adopted the existing theories of accident occurring. However, over a period of time the occurrence of accidents were found to be not aligned with proposed theories. This could be interpret as the Oil & Gas operations are exposed to high degree of risks which are resulting in low probability and high impact incidents. Some of the theoretical models are listed below:

**Simple Linear Models**

It assumes that accidents are culmination of a series of events or circumstances which interact sequentially with each other in a liner fashion and thus accidents are preventable by eliminating one of the causes in the liner sequence.

**Complex Linear Models**

It is based on presumption that are a result of a combination of unsafe act and latent hazard conditions within the system which follow a liner path. Accidents could be prevented focused on strengthening barriers and defenses.

**Complex-Non Linear Models**

Accidents can be thought of as resulting from combination of mutually interacting variables which occur in real world environments and it is only through understanding the combination and interaction of these multiple factors that accidents can truly be understood and prevented.
Domino Theory

The Domino theory, also known as Heinrich’s Domino theory, was developed by Herbert W. Heinrich in 1932. He is an engineer working for an insurance company in the USA in 1920’s studied 75000 reports of accidents gained from insurance files and industrial records. In 1931, Heinrich first published Industrial Accident Prevention, a text based on his findings from the analysis of the accident reports. It is considered the first scientific approach to accident prevention. According to Heinrich, an “accident” is one factor in a sequence that may lead to an injury. The factors can be visualized as a series of dominoes standing on edge; when one falls, the linkage required for a chain reaction is completed. Each of the factors is dependent on the preceding factor.

According to the Domino theory, a person injury (the final domino) occurs only as a result of an accident. An accident occurs only as a result of a personal or mechanical hazard. Personal and mechanical hazards exist only through the fault of careless persons or poorly designed or improperly maintained equipment.

Faults of persons are inherited or acquired as a result of their social environment or acquired by ancestry. The environment is where and how a person was raised and educated. The factor preceding the accident (the unsafe act or the mechanical or physical hazard) should receive the most attention. The concept is pictorially represented as
Human Factors Theory

According to this theory, human error is the basic cause of the accidents. The main causes attributed are:

- Overload
- The work task is beyond the capability of the worker
- Environmental factors includes noise and distractions
- Internal factors includes personal problems and emotional stress
- Situational factors includes unclear instructions and risk level

1.5.2 Source of data

Data for this research study was collected from various sources

- International Oil and Gas Producers (IOGP) who globally bench mark the Health, Safety and Environment performance of the industry.
- Accident / incident data from Cairn India limited an Oil & Gas Exploration and production company, India.
- UK Health Safety Executive’s publications (once in two months).
- OSHA (Occupational Safety and Health Administrative-USA)-Incident Rates of non-fatal occupational injuries and illness by industry and case types-2012.
- Various accident investigation reports published.
- Behavioural Safety Observations reports of Cairn India

1.5.3 Sampling

- Accident Analysis reports published in IOGP annual reports. These reports are based on benchmarking study contributed by 50+ major Oil & Gas companies in the worlds.
- Accident samples from Drilling, Exploration, Production Operations, Construction, brown field developmental activities of Oil & Gas.
- Detailed investigation reports of Cairn India, Barmer, Rajasthan an Oil & Gas Industry.
- Near-miss data and analysis reports of Cairn India, Barmer, Rajasthan operations.
- Questionnaire developed and responses obtained from safety professionals, line managers and leaders.
- Interaction with Injured personnel.

1.5.4 Statistical tools

- The result of the study with respect to accidents patterns compared with existing theories.
- Bow-tie-Xp tool used to identify the root causes of several accidents.
- BSCAT tool for analysing the failures of barriers in accident occurrence.
- Accident data comparison between IOGP and Cairn India, Indian Oil & Gas environment.
1.6 CONTENT OF THIS REPORT

The content of the thesis is structured in the following manner to achieve stated objectives of the research.

Chapter 1:

It deals with general introduction of research topics, its scope, objectives, overall research frameworks and research methodology.

Chapter 2:

It covers overview of accidents occurred in Oil and Gas Industry. The importance of Oil & Gas Industry in the business, the safety management system how it is important in considering and controlling various elements in accident occurring.

Chapter 3:

It deals with research Objectives focused on major accidents patterns in Oil & Gas activities, comparing the accident causations, inherent risk factors and current accident analysis models.

Chapter 4:

It illustrated the reviews made on existing literature in the similar field and allied field under various categories. It is focused on various disasters occurred and lessons learnt, human factors that are influencing the accidents in Oil & Gas and how the Organisations are dealing the problem.
Chapter 5:

It concludes the research with noticeable contributions in accident patterns in Oil and Gas (Upstream).

Chapter 6:

It includes References

Appendix is consolidated and given at the end for cross reference or verification purpose. The appendix includes definitions used in the thesis, two published papers and Curriculum Vitae of the scholar. This section concludes thesis report.