Abstract

Sustainability and OHS Global Reporting in Petrochemical Industries: The GRI Reporting Standard and Corporate Social Responsibility

by

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Sustainability reporting, an aspect of corporate social responsibility (i.e., CSR), is the practice of measuring, disclosing, and being accountable to internal and external stakeholders for organizational performance and the goal of sustainable development. Sustainability reporting is a broad term used to describe reporting on a firm economic, environmental, and social impacts. A sustainability report should provide a balanced and reasonable representation of the sustainability performance of a reporting organization, which includes both positive and negative contributions. (Global Reporting Initiative, 2011, p. 3). This paper describes the level of occupational health and safety reporting for the Chemical and Engineering News (C&EN) top 50 global chemical companies. The Global Reporting Initiative (GRI) standard *GRI: 403 Occupational Health and Safety 2018* was used as the basis for investigation. This paper explains how the growing interest in corporate social responsibility can contribute to improving the implementation of adequate systems of prevention and protection. Occupational health and safety in the petrochemical sector has become a great public interest and is associated with exposure risks to a variety of toxic chemicals and other agents which fuels questions surrounding

the necessary strategies required for safer petrochemical industries. The increasing pressure from challenges impeding the improvement of performance requires the need for establishing strategic roles aimed at restoring safety design systems while improving the roles of national health safety standards and corporate staff. This paper focuses on a set of three strategies aimed at improving occupational health and safety in the petrochemical sector including: (1) national/international standards and regulating agencies, (2) the role of health staff, and (3) strategic safety culture management. This is accomplished using a qualitative research design based on secondary data sources. Descriptive methods were used to analyze the qualitative data and the results presented through frequency tables, graphs, correlation matrices, and mean scores across study populations. The findings from this study reveal that a company's safety culture is a function of national OHS policies, safety rules and procedures, incentives, training, communication, worker involvement, safety manager commitment, and employee safety behavior. Safety culture is additionally observed as a reflection of the safety performance of firms in the petrochemical industry. Health staff can contribute towards health and safety training, the development of positive safety attitudes, and safety compliance. These statistics and evaluations are important because their role in establishing occupational health practices have been found to be effective in promoting, protecting, and rehabilitating the health and well-being of people. The study concludes that it is essential to establish the roles of health staff, national OHS standards, and safety culture management, and the means of achieving them.

Sustainability and OHS Global Reporting in Petrochemical Industries: The GRI Reporting Standard and Corporate Social Responsibility

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by
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Chapter 1: INTRODUCTION

This chapter highlights the background of the study, introduces the petrochemical industry and its associated occupational health and safety concerns, and provides a brief overview of the available strategies available which have the potential of increasing safety awareness and standards in the petrochemical sector. This study will focus on a set of three strategies which are aimed at improving occupational health and safety in the petrochemical sector. These strategies include (1) role of national Occupational Health and Safety (OHS) standards; (2) role of health staff; and (3) strategic safety culture management. This section also introduces the statement of the problem, research questions, and objectives of the study as well as the structure of the report.

1.1 Background of the Study

1.1.1 The petrochemical industry

> "The petrochemical industry is one of the world's largest economic sectors, responsible for the production of a wide range of goods and product commodities including organic and inorganic chemicals, synthetic fibers, synthetic rubber, plastics, pharmaceuticals and medicines, soaps, coatings and paints, fertilizers, pesticides, among other agricultural chemicals" (World Health Organization, 2014).

1.1.2 Petrochemicals

Derived from the process of fracking natural gas or crude oil, petrochemicals have been part and parcel of the manufacturing industry since the beginning of the 19th century (Russell, 2017). Petrochemicals were first incorporated as cheap substitutes for natural products. While they are generally safe in their finished product form, in their raw nature, petrochemicals are highly acidic and toxic and must be handled with care. Some of the

major petrochemicals include benzene, acetylene, ethane, methane, ethylene, hydrogen and propane. It is from these that hundreds of other chemicals are derived. These derivatives are used as plasticizers, fibers, elastomers and solvents and as feedstock used to produce thousands of other products. It is evident that these toxic chemicals in the petrochemical industry have resulted in occupational diseases and unhealthy working environments among other health and environmental impacts. Based on several risk and Environmental Impact Assessment (EIA) studies by researchers and organizations, it has become clear that the petrochemical industry exposes workers and the surrounding communities to great health, safety and environmental hazards. These hazards are due to the production of these toxic chemicals and their resultant obnoxious gas fumes that include nitrogen oxide, Sulphur oxide, carbon monoxide, fugitive hydrocarbons, volatile organic compounds and dust.

1.2 Approaches to Health and Safety in the Petrochemical Industry

Petrochemical safety is an important concern due to its role in protecting the lives of people and preventing the damage of property. Occupational health hazards are different from Occupational Safety Hazards. Occupational safety hazard is on the rise due to the growth of industrialization globally. The need to identify, prevent, and control them is imperative to the health and well-being of the workers. The health and well-being of the workforce in an organization, which is their most valuable asset, should be of great importance to management. ‘Health Hazards which could result in the development of diseases and sicknesses are categorized into physical health hazards, chemical health hazards, biological health hazards, mechanical/ergonomic health hazards, and

psychosocial health hazards. These health hazards, usually, could be associated with most industrialized organizations and commonly found in oil and gas Refineries (Eyayo, 2014).

Health and Safety performance can be measured in several different ways which range from compliance with existing international standards and applicable regulations to the amount of emissions to environmental costs to hazard indices (Al-sharrah & Elkamel, 2000). According to Boughaba (2014), safety performance can be measured based on data relating to accidents or injuries; including safety-related behaviors such as safety compliance and safety participation. Health and Safety performance can be measured in a few different ways which range from compliance with existing internal standards and applicable regulations and the amount of environmental emissions (Al-sharrah & Elkamel, 2000).

This study will focus on a set of strategies aimed at occupational health and safety in the petrochemical sector. These strategies include, national/international legal standards and regulating agencies, the role of health staff, and strategic safety management.

1.2.1 Role of National Strategies to Health and Safety

The main implementing regulation addressing occupational health and safety concerns in any country are the General Environmental Law and the Labor Law which are implemented by the Rules for Implementation. These laws set forth implementation methods, national requirements, and enforcement tactics (Isosceles Group, 2014). The local applicable facilities and the governmental authorities have the mandate to create plans in order to comply with the national standards and requirements. Most countries

lack specific regulations and standards (Isosceles Group, 2014). Occupation health and safety laws and regulations are limited with most contained in other laws and regulations related to health and safety and adopted on an ad-hoc basis.

1.2.2 Role of OHSMS in Occupational Health and Safety

The role of OHS management system in occupational health and safety in the petrochemical sector has been fueled by public concerns about risks of exposure to a variety of toxic chemicals and other agents (Yankauer & Rothman, 1984). This entails public health assessment, toxicological profiling, emergency response, exposure and disease registration, research on health effects, health education, and special initiatives in environmental health (World Health Organization, 2014).

OHS management system plays a major role in maintaining a level of sanity in terms of the operations carried out by the industry. One of these roles includes assessing potential hazards and their mitigation strategies. They, therefore, liaise with many stakeholders, such as the management, employees, and other professionals in the industry to identify ways through which proper management procedures may be put into use. Most of their activities are normally aimed towards ensuring that employees and other occupiers of the industry are safe. They also hold safety awareness as well as carrying out constant audits to ensure that employees and other members adhere to stipulations.

Under such a case, they can identify those areas that have seen better performance as well as identify those which require constant and improved action in order to deliver better outcomes that would be desirable. They also deliver health talks and health awareness messages to occupiers of the facility in which they operate. Such a

case drastically helps to ensure that they can motivate the occupiers to comply with the outlined recommendations (Junwei, Wei, Yajuan, & Qian, 2014).

1.2.3 Role of Strategic Safety Culture Management

As a science, safety can be claimed as having emerged from social ambitions for increased security and safety which includes the need for experimenting; developing; and testing practical tools, methods, and models with the aim of managing and understanding unwanted events or actions. Strategic safety management is the process through which safety management systems identify and analyze their associated risks. Such a system is important because it enables the effective distribution of key resources in all the high-risk environments of petrochemical plants. In order to ensure that workers operate in safe environments, it is essential that petrochemical plants operate at optimum levels starting with basic safety designs (Brown, 2014).

The safety of petrochemical plants should rely on technological measures to control and eliminate risks as well as to prevent accidents. Health and safety in the petrochemical industry is best addressed from two perspectives; occupational health and safety and process safety. The focus of process safety is prevention while occupational safety majorly covers the management of personal safety. Well-developed management systems, however, also address process safety concerns. The techniques, tools and programs that are needed to manage occupational and process safety can sometimes be the same, this includes permit to work systems (Brown, 2014).

1.2.3.1 Process safety

Process safety involves the prevention of spills, leaks, equipment malfunction, over-pressures, corrosion, over-temperatures, metal fatigue, and other similar conditions. In the petrochemical industry, programs of process safety should focus on engineering and design, together with training and maintenance of equipment (Brown, 2014). Efficient process safety is the result of a wide range of management, technical and operational disciplines.

Process control systems are used to protect the three Ps: people, plant and the planet. These systems are not used for controlling the process itself but for protection. Process control is achieved using process control systems (PCS) interlocked with safety systems to ensure that immediate actions are taken if the process control systems fail. Safety systems and process control are often merged to one system referred to as the Integrated Control and Safety System (ICSS) (Brown, 2014).

The petrochemical industry has three major types of safety systems, these include: the Process Safety System or Process Shutdown System (PSS); Safety Shutdown System (SSS) including the Emergency Shutdown (ESD), and Emergency Depressurization Systems Safety (EDP). The SSS is responsible for shutting down the industrial facilities to a safe state in the incidence of an emergency and hence protects personnel, assets, and the environment. The SSS also manages all the inputs and outputs in relation to the ESD functions (Brown, 2014).

The main aim of the fire and gas system is to protect people, the plant and the environment as well as the structures and equipment in the industry. These objectives are achieved by:

- Early detection of the presence of flammable gas,
- Early detection of any liquid spills like LPG or LNG,
- Early detection of the presence of fire and incipient fire,
- Providing facilities for activation of fire protection systems as required,
- Initiating environmental changed aimed at keeping liquids below their respective flashpoints,
- Initiating both visible and audible signals as required to alert of detected hazards,
- Initiating the exhausting system, and
- Emergency Depressurization (EDP) Systems (Brown, 2014).

To avoid unnecessary pressure, increase in piping and vessels, there is need to ensure that the ESD valves are closed. Any trapped flammable fluids are then released. As a result, the EDP systems are used together with ESD systems to release the trapped fluids to a safe location and in a safe manner (Brown, 2014).

The final safety solution used if all the previous systems fail are the Pressure Safety Valves (PSVs). PSVs are mechanical devices that help to prevent the accumulation of pressure in vessels. Process safety in the petrochemical industry has the potential of achieving maximum benefit if the following practices are adhered to:

- Top management leadership discuss process safety in board meetings,
- Visible commitment and visibility of the top management through open dialogues and site visits,

- Improving administrative and engineered safeguards aimed at maintaining or achieving an improved a safe state process,
- Establishing a set of integrated lagging and leading performance indicators which regularly updated, and
- Reviewing industry recommendations and incidents across major hazard sectors for purposes of learning and improvement (Brown, 2014).

1.2.3.2 Occupational Safety

In the petrochemical industry, the management of occupational health and safety (OHS) risks is a key requirement in every workplace. To help establish framework that complies with the two major elements of most OHS legislation, there is need for an effective OHS management system (Brown, 2014). These two elements of OHS legislation are:

- The requirement of employers to provide and maintain a safe working environment that is without risk, and
- The requirement of employees to take care reasonable care for their health and safety and that of others.

The following elements will help to safeguard employees' health and safety in the petrochemical industry, these include: emergency preparedness, safety culture, and training.

1.2.3.3 Safety Training

Simple safety training such as personal protective equipment (PPE) training including gloves and safety glasses for handling petrochemicals, identifying unsafe work

conditions and procedures, and being ware of environmental anomalies like smoke or stray smells can help to ensure the petrochemical facility runs efficiently and safely without incidences. It is necessary to train employees on safety around these hazardous chemicals during normal operations. It is also essential to train all employees on what they have to do in the incidence of an accident (Brown, 2014). Key hazardous material procedures include the need for shutting down all electrical activity in the event of a flammable spill as well as the use of surrounding safety equipment as well as other resources to contain spillage or evacuation management to ensure that everyone is safe.

1.2.3.4 Emergency chemical spill treatment

All workers should be aware of special emergency treatment in the event of personal contamination with chemicals due to the capacity of chemicals to burn the skin and to damage the eyes. Employees should be well informed of nearest emergency wash areas and restrooms to their duty stations (Brown, 2014). They should additionally be informed that spills on the eyes and on the skin ought to be flushed away with large amount of filtered water to reduce damage; similarly, victims of inhalation must be taken out to inhale copious amounts of fresh air as soon as possible (Brown, 2014).

1.2.3.5 Safety Culture

Safety is defined as an acceptable or the smallest possible risk whereas risk the result of potential damages and the probability of occurrence. (Grote, 2007). Over the last two decades there have been increases in the need for a change in the definition of what is regarded as ‘acceptable’ in OHS performance especially in the petrochemical industry (Brown, 2014).

Safety culture in the petrochemical industry can be examined based on a set of three levels of cultures, these are: basic assumptions, observable artefacts, and espoused values. The following components of the safety culture are described under the respective appropriate level, basic assumption, and or espoused value:

- *Commitment:* The perception of an employee to an organization's safety commitment is an important safety culture (Institute for Safety and Health Management, 2017). Employees have higher probabilities of complying when the organizational managers set a positive safe example.
- *Involvement:* More employees must be involved in safety. It is important that the practice of daily participation in decision making processes is inculcated in safety performance whether formal or informal. A sense of connection to the process will encourage workers to stay motivated and to work in safer environments as well as empower others to do the same. Those workers left out from the process often feel disconnected from the decision-making and this makes them likely to feel devalued and disinterested and hence the potential for reduced safe practices (Brown, 2014).
- *Competition:* This entails a combination of skills, experience and knowledge aimed at ensuring that there is a safe completion of jobs in the event of hazards (Furness and Muckett, 2007).
- *Compliance*: Failure to comply with safety precautions and procedures is non-negotiable. There ought to be no room for ignoring safety requirements (Taylor, 2002). Even though procedure and regulations

signify a weak safety culture, the management must be cautious of hiding behind compliance to save employers.

- *Accountability*: Every employee in the petrochemical industry is accountable for not only their safety but also for that of their colleagues. Accountability demands for the need of workers to exercise safety in their daily work tasks. This also requires the need for addressing and identifying potential hazards and problems that may occur in the industry and elsewhere in the workplace (Barraclough & Carnino, 1998).
- *Communication*: A key characteristic of industries with good safety culture is effective communication systems. There is need for thorough communication of safety information with the inclusion of both bottom and bi-directional communication. In addition, an organization ought to have an atmosphere that promotes constant and open communication free from retribution. Open-door policies and face to face communication channels are key in eliminating the barriers of communication. Employees should be comfortable to be able to convey concerns of great importance to the top management (Olive et al., 2006).
- *Learning:* There is need for compressive continuous training for all employees and not sporadic classroom lessons. This training must be relevant to all employees. An effective safety culture thrives on an organizational commitment to continuous learning. The lessons include knowledge on safety situations encountered and their respective root causes.

- *Trust:* Employees must feel secure and comfortable when questioning their safety, and hence the need for ‘no blame’ culture to ensure safety culture is maintained. Some organizations have set up initiatives of rewarding employees who provide safety information to encourage trust. Issues of trust are often intertwined in a complex structure with other elements of safety culture (Brown, 2014).
- *Recognition:* The recognition and rewarding of positive behaviors like Pavlovian conditioning has the capacity to reinforce workers. People who are appreciated have a higher chance of being happy when performing their task as well as to work harder. Positive reinforcement through recognition is a significant tool that is being used to improve safety culture (IAEA, 2002).
- *Group Mentality*: Humans generally strive to be in groups because they are social creature (Duncan, 2012). It is easier to bring most employees to positive behavior of most of the group members demonstrate positive safety behaviors. New staff have an inclination of falling in line with what they perceive as normal behavior of the workplace. Positive safety culture and behavior from the top management has the potential of permeating top-down through the ranks and establish a strong organizational safety culture.

Safety is of paramount significance in an extremely high-risk environment as a petrochemical plant. Over the past decade there have been great improvements in OHS in the petrochemical industry, but there is need for more to be done. The design of risk

from the equation is not a solution because of the occurrence of accidents and user errors. Therefore, it is important to ensure that all workers are well equipped with the necessary knowledge and protection to handle any hazards that may occur.

1.3 Statement of the Research Problem

There has been an increase in public concerns about risks of exposure to a variety of toxic chemicals and other agents, thus necessitating an analysis of the role of key actors and safety measures including OHS standards and staff safety processess such as strategic safety management in occupational health and safety in the petrochemical sector (Yankauer & Rothman, 1984). With the growth and development of various industries, there is a heightened use of chemicals and petroleum products. Many elements used around the world in industries, agriculture, transport, and other sectors use the same elements (Junweiet al., 2014). There is a chance that with the continued use, there is a need for advancements that are aimed at ensuring petroleum safety. To help deal with the various problems associated with petrochemical industry, there is the need for integrating all relevant stakeholders including; health staff, national/international governments, and safety management processes like safety culture in industries.

Occupational health was defined as “the highest degree of physical, mental and social well-being of workers in all occupation” by The Joint International Labor Organization Committee on Occupational Health, (1950). Whereas a hazard is a source of danger that could cause injury or harm (Navy & Marine Corps Public Health Centre, 2010). “Occupational hazards are dangers to human health and well-being which are associated with specific occupations.

Occupational or workplace hazard is a danger to health, limb, or life that is inherent in or is associated with, a particular occupation, industry, or work environment" (Eyayo, 2014). It includes the risk of accident and of contracting occupational disease (Business Dictionary, 2013).

> "Hazard is not deemed to be synonymous with risk although it can be an important determinant of risk. Although risk may be related to a chance event and expressed as a probability, there is much more to it than that. Probability is not an entirely haphazard one of course but relates to several factors. However, in occupational and environmental epidemiology, we prefer to define these two words as follows: hazard is the potential to cause harm; and risk, on the other hand, is the likelihood of harm (in defined circumstances, and usually qualified by some statement of the severity of the harm" (Eyayo, 2014).

Almanssoor (2008) defines an environmental hazard as potential to cause harm to the environment. Chemical plants are usually environmentally hazardous because they typically contain large inventories of ecotoxic chemicals in addition to the emissions and releases from the chemical process.

These environmental hazards due to chemicals have been defined as a function of two elements (Cave et al., 1997): (1) the damage that the chemical could cause to the environment following a loss of contaminant that is the effect of chemical and (2) the quantity of chemical involved that is the exposure of the chemical.

Industry workers are involuntarily exposed to a wide range of known and suspected carcinogens in the workplace. All these chemicals, if managed improperly, pose risks to human health and the environment. According to the World Health

Organization (WHO) estimates, in 2004, 4.9 million deaths (8.3% of the total) and 86 million disability-adjusted life years (5.7% of the total) were attributable to environmental and occupational exposures resulting from the unsound management of selected chemicals" (World Health Organization, 2014). It was estimated that approximately 2 million deaths occur globally every year due to occupational diseases, with 32% attributable to occupational cancer (Veglia et al., 2016).

Consumers, employees, shareholders, legislators, and the communities for which the industry operates are all becoming increasingly aware of health, safety and environmental issues and demand ever-higher standards. Public trust and public belief in corporate responsiveness stem from the ability of organizations to uphold transparency in health and safety compliance issues. A comparative study in two industrial towns, by Phillimore, Hoeldke, Moffat, Pless-Mulloli, Bell, and Schlueter (2004) revealed that corporate transparency builds trust in the long term, in the process developing a public belief in corporate responsiveness. The willingness to acknowledge long-term local obligations and economic security create foundations for trust on which transparency can build. Therefore, it is essential to include the health, safety and environmental aspect in the strategy for any industry. "No industry will hold a strong position in the national or international market without adhering to and respecting HSE rules" (Al-sharrah & Elkamel, 2000).

1.4 Research Gap

Occupational health and safety in the petrochemical sector have become a great public associated with risks of exposure to a variety of toxic chemicals and other agents

fueling questions on the key strategies that must be developed towards the realization of safer petrochemical industries (Yankauer & Rothman, 1984). Most studies in the field of health and safety in the petrochemical industry focus on generalized petrochemical manufacturers and the implementation of occupational health and safety systems and requirements. A study by Fuller and Vassie (2005) for instance assessed only the key inputs to and outputs from supervisory processes used within the chemical sector considering that it is regarded as a high-risk industry that must be carefully regulated and controlled. Few studies are yet to explore a holistic approach towards establishing the role of all relevant stakeholders in the industries. Most studies and literature which link matters of occupational health to the petrochemical industry fail to outline the specific roles played by key players, institutions and processes. These include health staff, national OHS standards and regulating agencies, as well as the process of strategic safety management.

This study aims at filling in these gaps among the key players at the center of ensuring workers in the industry work in safe environments; the specific roles played by national OHS standards in the petrochemical industry; the level of interaction between health staff and key players in the petrochemical industry as well as the steps needed to be taken in establishing functional safety culture management processes in order to improve health and safety in the petrochemical industry.

1.5 Questions and Objectives

This study seeks to describe the occupational health and safety reporting of the top 50 global chemical companies according to C & EN. The 2018 Global Reporting

Initiative standard 403 for Occupational Health and Safety will be utilized as the criterion to determine the components.

1.6 Significance of the Study

"The human, social and economic costs of occupational accidents, injuries and diseases and major industrial disasters have long been cause for concern at all levels from the individual workplace to the national and international" (Eyayo, 2014). The involvement of governments through legal provisions, the health staff together with safety management process like strategic safety management might be one of the solutions to minimizing these costs. Therefore, this study sought to raise ideas and issues which pertain to the importance of health staff and the strategic safety management processes that need to be appreciated and implemented by other stakeholders in the petrochemical industry, like manufacturers and regulatory authorities. These issues build on occupational, health and safety matters which contribute to the survival and success of firms in the industry in terms of sustainability, efficiency, public trust and compliance

Chapter 2: LITERATURE REVIEW

2.1 Introduction

In order to address the aim of the research, it is important to establish a sound literature base around which the study is built. The order of the literature review is structured in relation to the needs of research question on the strategies to safety and health in the petrochemical industry.

2.2 Overview and Structure of the Petrochemical Industry

The petrochemical industry is based upon the production of chemicals from petroleum. It also deals with chemicals manufactured from the by-products of petroleum refining, such as natural gas, natural gas liquids, and tar (Almanssoor, 2008). This industry began with the successful drilling of the first commercial oil well in 1859, and the opening of the first refinery two years later in order to process crude into kerosene (Eyayo, 2014). The evolution of petroleum refining from simple distillation to today's sophisticated processes has created a need for health and safety management procedures and safe work practices. The safe and orderly processing of crude oil into flammable gasses and liquids at high temperatures and pressures using vessels, equipment, and piping subjected to stress and corrosion requires considerable knowledge, control, and expertise. Safety and health professionals, working with process, chemical, instrumentation, and metallurgical engineers, assure that potential physical, mechanical, chemical, and health hazards are recognized, and provisions are made for safe operating practices and appropriate protective measures.

These measures may include hard hats, safety glasses and goggles, safety shoes, hearing protection, respiratory protection, and protective clothing such as fire-resistant clothing where required. In addition, procedures should be established to assure compliance with applicable regulations and standards such as hazard communications, confined space entry, and process safety management" (Eyayo, 2014). "This industry is one of the world's largest economic sectors, producing organic and inorganic chemicals, plastics, synthetic fibers, pharmaceuticals and medicines, synthetic rubber, soaps, paints and coatings, pesticides, fertilizers and other agricultural chemicals" (World Health Organization, 2014). The production chain begins with raw feedstocks such as petroleum, natural gas, and tar. From these, a relatively small number of important building blocks are produced. These include the lower olefins and aromatics, such as ethylene, propylene, butylene, butadiene, benzene, toluene, and xylene. These outputs are then converted into a complex array of thousands of intermediate chemicals, some of which have commercial value as final products, while others are purely intermediates (Almanssoor, 2008).

2.2.1 Risks Associated with the Petrochemical Industry

This production process not only exposes workers in the industry to dangerous working conditions but also potentially endangers the society and environment at large, in terms of the emissions, dumping of waste products. The industry workers are involuntarily exposed to a wide range of known and suspected carcinogens in the workplace. "All these chemicals, if managed improperly, pose risks to human health and the environment. According to the World Health Organization estimates, in 2004, 4.9 million deaths (8.3% of the total) and 86 million disability-adjusted life years (5.7% of the

total) were attributable to environmental and occupational exposures resulting from the unsound management of selected chemicals" (World Health Organization, 2014).

It was estimated that approximately 2 million deaths occur globally every year due to occupational diseases, with 32% attributable to occupational cancer (Veglia et al., 2016). An ongoing study in Canada aims at quantifying the proportion of cancers attributed to occupational exposures and the associated economic costs.

A study by Leblanc et al. (2014) shows that petrochemicals are likely to cause advance health effects upon people when proper measures are not put in place to achieve better outcomes. It also indicates that consistent measures need to be put in place in a bid to achieve some level of success in terms of how more people could be protected from harm and as well, damage to different infrastructure may not come to fruition. This justifies the importance of occupational health and safety policies advocated by the industry players. These are manifested in the form of safety systems, policy frameworks, and management structures. However, primary prevention policies and investment in Occupational Health and Safety, in general, are less apparent in many countries primarily due to competing for social, economic, and political challenges (Veglia et al., 2016).

Li (2016) in his study also states that people need to be made aware of the strategies that may be applied in a bid to achieve some level of petrochemical safety. Under such a case, it is of the essence to have health staff who shall be informing the individuals on the kind of actions that they need to take in order to have better outcomes in relations to the level of interaction they have with elements contained in the industry. They will also be able to show them the importance of maintaining better hygiene

standards in the industry. It is also established that the concept of information sharing needs to be highly consistent.

The health staff who come up with the right strategies aimed towards petroleum safety need to be willing to provide the insights to other individuals and agencies, in such a way that they shall be able to take actions aimed towards achieving high levels of safety.

2.3 Overview of Occupational Health and Occupational Health Hazards

Occupational health is defined as,

> "a means of protecting and maintaining the physical, psychological and social health of workers and their families. It can also be viewed as the study of factors or conditions influencing the health and well-being of workers not only in the place of work but also at home with the aim of promoting health, safety, and welfare of the workers and their family" (Eyayo, 2014).

The joint International Labor Organization (ILO) and the World Health Organization (WHO) defined Occupational Health as the "promotion and maintenance of the highest degree of physical, mental and social well-being of workers in all occupation". This was further summarized by the International Labor Organization as the

> "prevention of departure from health among workers caused by their working conditions; the promotion of workers in their employment from risks resulting from factors adverse to health, the placing and maintenance of the worker in an occupational environment adapted to their physical and psychological well-being; and the adaptation of work to man and man to his work."

Eyayo (2014) further states that “Dr. Yakemi describes it as the health investment for workers to help them spend their working lives in a healthy way both mentally and physically and enable them to enjoy better health in later life as well. It is the sum of all the activities and programs that are aimed at preventing, protecting and maintaining the highest level of health and safety among workers in any work environment which can be industrial, non-industrial or private or organizational”.

Eyayo (2014) observed that workplace health hazards differ from those found in the general environment. She attributed this to the fact that “workers are often exposed in confined spaces, exposure levels to workplace hazards are often much higher than exposures to hazards in the general environment.” The Global Strategy on Occupational Health for All (1996) summarizes workplace hazards as follows:

> “occupational health hazards are broadly divided into physical, chemical, biological, behavioral, psychosocial, and mechanical/ergonomics. Physical hazards are often said to be less important than chemical hazards, but this is not so. They can and do cause several health problems, injuries or even death”.

The nature of physical agents is wide and should not be underrated but the main ones capable of causing occupational disorders and injuries are: noise; illumination; vibration; radiation (ionizing and non-ionizing) and microclimatic conditions in cases of extreme heat and cold (World Health Organization, 2013).

Mechanical and ergonomics hazards are those attributed to unshielded machinery, unsafe structures in the workplace and dangerous tools, which are some of the most prevalent workplace hazards in both developed and developing countries (Global Strategy on Occupational Health for All, 1996). On the other hand, “chemical hazards

could be classified into particles, fibers, fumes and mist (carbon black, welding fume, oil mist; metals and metalloids (Arsenic, Cadmium, Chromium, Mercury, Zinc); Organic, solvents and compounds (Acetone, hydrocarbons, Benzene); Inorganic gases (Carbon monoxide, Hydrogen sulphide, Sulphur dioxide)" (Eyayo, 2014). Health effects of chemical hazards include; metal poisoning, pesticide poisoning, damage to the central nervous system and liver, dermal and respiratory allergies, dermatoses, cancers and reproductive disorders (Eyayo, 2014).

2.3.1 Safety and Compliance Issues in the Petrochemical Industry

To stay competitive in today's more globally oriented market, manufacturing firms in this industry need to understand the strategic, tactical and operational issues which will ensure sustained competitive positioning. Among the widely recognized goals for a development strategy is sustainability or sustainable development. The latter refers to "economic development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987). The two most important indicators of sustainability are economical gain and health safety and environmental (HSE) protection (Al-sharrah & Elkamel, 2000). "Poor performance in occupational health and safety (OHS) can take a heavy financial toll on any business, not to mention the human cost of work-related illness, injury, and fatality.

This is the primary aim of an effective Occupational Health Safety – Management System (OHS – MS). The implementation of such a system can also help your business to deal with the legal imperatives, ethical concerns, industrial relations considerations relating to workplace safety, and to improve its financial performance" (Eyayo, 2014).

Health Safety and Environmental issues are a concern for all industries, but particularly for the petrochemical industry. The consumers, employees, shareholders, legislators and the communities for which the industry operates are all becoming increasingly aware of health safety and environmental issues and demand ever-higher standards. Therefore, it is essential to include the health, safety and environmental aspect in the strategy for any industry. No industry will hold a strong position in the national or international market without adhering to and respecting health, safety and environmental rules" (Al-sharrah & Elkamel, 2000). "Consequently, health effect management process which is an element in Occupational Health and Safety Management System (OHS-MS) amongst others is recommended management protocol that would assist the management of an Oil and Gas Refinery to protect, promote and rehabilitate the health and well-being of their workers (Eyayo, 2014).

2.3.2 Health Safety and Environmental Tools

These are used by design engineers in the petrochemical industry to ensure compliance with OHS requirements. A study by Young and Cabezas (1999), as cited in Al-sharrah and Elkamel (2000), used the Waste Reduction (WAR) algorithm; a tool that aid evaluating the environmental friendliness of a production process. It determines the potential environmental impact of a chemical process and of the energy consumed within the process. Steffens et al. (1999) used Life Cycle Analysis (LCA) and the Sustainable Process Index (SPI).

LCA identifies and quantifies the environmental performance of a process while the SPI does not focus on the impact of pollutant streams leaving the system, but instead evaluates the sustainability of the whole system. "In the petrochemical industry, the first

forms of simple safety indices for health, safety, and environmental strategic planning started in the 1980s after the development of optimization models for the industry. The indices at that time were very simple; they were the first introduction of safety into planning. Fathi-Afshar and Yang (1985) selected the chemical Threshold Limit Value (TLV) (concentration of a substance in the air to which workers can be exposed to without adverse effects) as an indicator for a health objective function" (Al-sharrah & Elkamel, 2000).

There are other groups of safety indices which present more detailed approaches to quantifying safety in early stages of health safety and environmental strategic planning. For example,

> " the Edwards and Lawrence (1993) and the Heikkila et al. (1996) indices. These indices have been calculated as a total score, which is the sum of a chemical score and a process score and taking into consideration many manufacturing parameters such as inventory, flammability as flash point and boiling point, explosiveness as a difference between explosion limits and toxicity as Threshold Limit Value (TLV), temperature and pressure" (Al-sharrah and Elkamel, 2000).

Another one is the Environmental Hazard Index (EHI) by Cave and Edwards (1997) which ranks routes (raw materials and reactions to produce the final product) in chemical plant development by the estimated environmental impact of a total release of chemical inventory. This index assesses the hazard to the aquatic and the terrestrial ecosystems (Al-sharrah & Elkamel, 2000).

Another index is the Atmospheric Hazard Index (AHI) by Gunasekera and Edwards (2001, 2003). It can be used to assess the potential impact of airborne releases from a

chemical production plant. A catastrophic failure of the plant is assumed and the impact on the atmospheric environment is estimated. The atmospheric impact categories considered were the toxicity, photochemical smog, acid deposition, global warming and ozone depletion of a chemical when it is released catastrophically into the environment" (Al-sharrah and Elkamel, 2000).

2.3.3 Safety Performance of Petrochemical Firms

Safety performance is the measurement of a petrochemical firm's achievement in safety management. Health and Safety performance can be measured in several different ways which range from compliance with existing internal standards and applicable regulations to the amount of emissions to environmental costs to hazard indices (Al-sharrah and Elkamel, 2000). According to Boughaba et al. (2014) safety performance can be measured based on data relating to accidents or injuries; safety-related behaviors such as safety compliance and safety participation. These reflect an organization's safety culture, which is a function of safety policies, safety rules and procedures, incentives, training, communication, workers' involvement, safety managers' commitment, and employees' safety behavior.

Minimum safety standards at work, such as following safety procedures and wearing required protective equipment. "Safety participation represents the behavior of employees in ways that increase the safety and health of co-workers and that support an organization's stated goals and objectives, such as helping coworkers with safety-related issues or voluntarily attending safety meetings" (Boughaba et al., 2014).

According to Mulla (2007) "measurement techniques for safety performance and culture measurement of safety performance and safety culture is not based on a single

factor or aspect. The safety process measures can be classified into: specific factors (incidents/accidents reporting, policy, emergency procedures); management factors (management of change, leadership, communication, hiring placement, purchasing controls); technical factors (maintenance management, levels of automation, human-system interface, engineering controls, design, hardware); procedural factors (standards, rules, administrative controls, operating procedure) and training factors (formal versus informal methods, skills, competencies development, training department, etc.). However, the most significant of these are cultural factors which include commitment, competence, and cognizance. In order to maintain the responsibility of OHS with factories and employers, OHS has yet to be mainstreamed into the wider health agenda. This situation has continued to the present day as national health ministry's often attempting to implement occupational health services for all employees with limited exceptions in the private sector. Workers have at the same time taken advantage of the growing number of private sector actors and have made decisions to outsource matters concerning health and safety in the workplace on the grounds of seeking subsidized costs.

All the relevant agencies and individuals involved in this process have the responsibility of considering how they contribute to the debate of OHS, ensuring that they do not confuse occupational health with the need to improve the wider national health improvement agendas, while at the same time keeping in mind that the need to improve national health has impact on national economies. It is also important to note that it is the role of health ministries to work with a broad range of stakeholder to improve and promote OHS for working populations. Even though these initiatives are welcome as strategies to health and safety, there are still concerns that they are far from comprehensive OHS

services that ought to be delivered to working populations. Considering the ongoing concerns to health and safety it is suitable that a close examination is made on the how national governments through their respective ministries of labor and ministry of Industry and Commerce can participate in shaping work-related OHS concerns of the present and of the future, besides the roles of examining current OHS health resources and how these services can be developed.

2.3.4 Petrochemical Industries and their OSH Responsibilities

The following are some of the principles that Ministries of Health can consider when making decisions about plans and programs for comprehensive OHS systems:

- Avoid and manage all OHS risks
- Create a high level of health quality for all workers
- Eliminate the impact of unhealthy work practices
- Aid workers who may have work related health illnesses and /or injuries
- Establish measures for possible return to work after work related injuries or illness.

In accordance to Everly (1986), it is the duty of employers to point out the liability for the implementation of workplace safety. This is in close agreement with Rougton's observation that it is the main responsibility of the employer to prevent all workplace accidents and incidents that may lead to illness and injuries (Rougton's , 2010). Employers therefore have a legal responsibility to ensure that they protect the health and safety of their employees as is outlined in laws on hazardous works. However as pertains to most employers, they disregard their ethical and legal obligations to their employees.

Workplace and Safety Assessment

The following Guides to Safety and Health Regulation are essential components that can be used when assessing OHS concerns and their effectiveness in the Health and Safety (2009). These include:

- Identification of hazards
- Risk management
- Provision of information

It is the prerogative of national governments to recognize the connection between accessible and comprehensible OHS policies and their role in ensuring workplace health and safety. It crucial that petrochemical industries and business realize that they must cooperate in implementing occupational health and safety guidelines to create a sense of assurance and self-confidence to workers and to protect employer right to regulate work policies.

In Saudi Arabia for instance, the Royal Decree No. M/21 dated 6 Ramadhan 1389 (1969) clearly outlines that the Ministry of Commerce, the Ministry of Labor and the Industry of Saudi Arabia have equal obligations of reducing the number of losses of skilled workers as a result of work-related injuries and safety and ensure they remain as low as possible. The Ministry of Labor in Saudi requested for the need of Saudi employers to develop and maintain positive and best workplace OHS practice to sustain both trained and experienced workers. It is hence the role of petrochemical industries to consult with OHS experts and to explore advise on reasonable adjustments that can be made or suitable alternate measures that can be taken to ensure the safety of all employees and to recognize the cost effectiveness of implementing high quality policies that are fairly and constructively designed.

Fire Safety in the Small Business in the Petrochemical Industry

Small businesses in the petrochemical industry are one of the most vulnerable as they often lack monetary resources for employing full time health and safety experts. It is however important that health and safety is highly regarded even in small business as they work towards growing even in hard economic climates. Small businesses also have to adhere to OHS procedures and practices because they are also liable if they fail to comply to the regulation set in place. In addition, their employees have to be well protected in the work place and there are legal provisions for their protection.

Fires safety is a big component of health and safety in the petrochemical industry including in small business in the industry. It is essential that workers know how to exit the buildings and industrial areas in a safe and organized way in the event of a fire alarm. This is often practiced among workers, however there are a number some employers who think that fire drills are a waste of business time and resources (European Agency for Safety and Health at Work, 2007).

In work areas where employees are always changing, there is need for new staff to gain familiarity with the location of fire exits in the event of fire occurrences. They also have to know how to proceed by themselves. The main of objective of fire drills for effective emergency response is preparation (Health and Safety Executive, 2009). In Great Britain, a guide to Safety and Health Regulation established that conducting effective fire drills helps industrial owners to be responsible for fire safety (Office of the Fire Marshal, 2004). The aim of a fire drill is learning how to provide timely resources and to show whether the personnel are confident enough to deal with emergency fires. Fire drills are an easy way to measure the effectiveness of safety measures in the workplace

as well as to understand whether safety measures are in compliance with the mandatory safety regulations for work places.

It is the responsibility of industrial owners in the petrochemical industry to ensure that all the work personnel have a good knowledge and understanding of the following:

- All workers know how to initiate a fire alarm in the event of fire and to also know how to contact the fire safety department.
- Workers should be well prepared to use firefighting equipment and tools.
- Workers should know the location of emergency exits and to be able to report to other these locations.

Employee Safety

Employers have the duty to ensure that their workers feel safe. A famous stament the industrial work sector told us that “people leave people and not their jobs.” It is important that industries investigate why approximately 40% of employees perceive that they work for “bad bosses” and how this impact on organizational productivity. It is well confirmed and obvious that this observation applies well to support and management staff. If line managers in industries are well educated to manage OHS related injuries and illness, then there is a greater chance that workers will maintain their jobs and that the risks of occupational ill-health will be eliminated and drastically reduced. This observation is not only limited to the private sector but also to line manager concerns in governmental and other public space workplaces.

It is important that employers have a clear understanding of how their employees feel about their peers and other workers as well as line managers. A safe and hazards free workplace is extremely significant and can be the difference between maintaining

workers or losing them. Staff training and development is a good way through which the confidence of workers can be increased, and their skills furnished. Investment in the skills of workers benefits not only the employees but also the industries.

Governments should be responsible for the establishment of centers for healthy working people aimed at providing information and to advise both employers and workers on issues concerning workplace health and safety concerns. Such a database can also provide data on occupational health specialists, complimentary therapists, and counselors among others.

Even though it is the duty of employers to provide employees with these health services, it is also important for national governments through their respective Ministries of Labor, Ministry of Commerce and Industry, the labor market and stakeholders in the workforce to work towards the establishment of a functional OHS system. Such an institution while working in collaboration with other international organizations and other partners ought to work towards the achievement of the following goals:

- The effective management of workplace hazards as part of corporate risk management and national practices. This involves; invigorative and innovative health committees and education of workers with the knowledge of OHS.
- Information on data base to promote National occupational health and safety
- Development of workplaces consultation, training and safe and easy to use workplace safety tools and methods.

- Control of chemical occupational hazards while exploiting new opportunities.

In order to achieve these goals, there is need for:

- Campaigns aimed at focusing on workplace health and safety concerns and to raise awareness on hazardous conditions in the workplace and the consequent costs to the nation and the society.
- Involvement of University research groups to develop future workplace preventive and safety strategies.
- Ministries of health and labor should engage with other related groups and academics to identify all the possible health and safety risks that are associated with new technologies like the exposure to nonmaterial and to work towards the implementation of health screening procedures.

National stakeholder engagement and capacity have a crucial role in the development of a comprehensive occupational workplace health and safety strategy. These national stakeholders should work towards the introduction of new modern regulations to develop national occupational health services that involve employers, investors as well as health and government services. In their research, Jannadi and Al-Sudairi (1995) stated that the role of providing health and safety in the workplace is the role of owners and relevant government bodies. National stakeholder groups should then be interested in changing the work environment, identification of potentials for rapid change in the country specific industrial maps though the introduction of nanotechnologies and to effectively move new industries into new eras. These stakeholder groups should additionally recognize the repercussions of the work

environment that are caused by rapid industrial permanent change. There are significant gaps present in the coverage of workplace health and safety and training and services that are accessible to all workers. This highlights that there is need for applying a safety code in Saudi Arabia aimed at monitoring health and safety requirements in the workplace. It is important for Saudi employers not to separate the important aspects of health interventions from OHS. These are all significant to the values of the stakeholder groups but should not overshadow the support for the health and safety agenda despite their focus on the OHS agenda. There is need to examine the quality of the health and safety practices of the private sector along with a campaign to ensure that all employers participate in the planning of OHS in their respective workplaces.

2.4 Roles of Health staff in the Petrochemical Industry

The role of health staff in occupational health and safety in the petrochemical sector has been fueled by public concerns about risks of exposure to a variety of toxic chemicals and other agents (Yankauer & Rothman, 1984). The Strategy for Strengthening the Engagement of the Health Sector in the Implementation of Strategic Approach to International Chemicals Management (SAICM) was approved in 2012, at the third session of the International Conference on Chemicals Management held in Nairobi, Kenya. “It was emphasized that, given the position of trust held by doctors, nurses and other community health workers, the health sector workforce is central to credible communication with the public” (World Health Organization, 2014). There are other World Health Assembly resolutions which require the health sector to build capacity and

implement measures necessary to prevent the negative health impact of hazardous chemicals.

The involvement of the health sector benefits the collection of information on, and the prevention of, health effects (World Health Organization, 2014). This report further states that health staff are “responsible for public health assessment; toxicological profiling; emergency response; exposure and disease registration; research on health effects; health education; and special initiatives in environmental health”.

Provision of Information and Guidance for the Public

Public health agencies are expected to protect and advise the public on health problems associated with environmental agents. According to Yankauer and Rothman (1984), health departments protect the community, conduct epidemiological investigation, and public education. They observed that environmental agencies are passing the responsibility for risk assessment to the public health officials. These health agencies can protect the health of the public with the aid of modern technology for health risk assessment, laboratory analysis, and epidemiologic studies (Yankauer & Rothman, 1984). Public health agencies collect and disseminate information on the health effects and other health-related aspects of chemical safety. The health sector provides the public with advice on how to protect themselves from hazards resulting from exposure to chemicals, poisons, and radiation (World Health Organization, 2014). Through biological monitoring information, the health sector characterizes hazard and dose response of exposure to chemicals. The information collected is tabulated and communicated through environmental chemical publications; biomonitoring summaries; national reports; chemical fact sheets (World Health Organization, 2014).

2.4.1 Health promotion and worker well-being

Health staff educate industry players on matters of occupational health. They help in the realization of industrial hygiene, which has been defined as

> "the science and art devoted to the anticipation, recognition, evaluation, and control of those environmental factors or stresses arising in or from the workplace, which may cause sickness, impaired health and well-being, or significant discomfort among workers or among the citizens of the community" (Occupational Health & Safety Administration, 1998).

Industrial hygiene entails the use environmental monitoring and analytical methods to detect the extent of worker exposure and employ engineering, work practice controls, and other methods to control potential health hazards. It has been proven that awareness of industrial hygiene that is well-designed, ergonomic work environment, brings about benefits such as increased efficiency, fewer accidents, lower operating costs, and more effective use of personnel (Occupational Health & Safety Administration, 1998). For instance, in 2010–2011, the World Health Organization conducted capacity-building activities on public health management of chemical incidents and chemical risk assessment, in form of regional and national workshops and training events (World Health Organization, 2014). This also involves planning and developing educational packages containing all the information and the training material necessary to empower people on response to public health threats, such as attacks with biological, chemical and radiological agents (World Health Organization, 2014).

2.4.2 Development of safety culture and safety performance

Safety culture, the main indicator of safety performance, is the product of interactions between people (psychological factors), jobs (behavioral factors), and the organization (situational factors) (Boughaba, Hassane, & Roukia, 2014). It entails Health, Safety, and the Environment management systems, policies and training of workers in the petrochemical sector in safety management. Boughaba, Hassane, and Roukia (2014) found that safety culture generates safety motivation and safety compliance, consequently, safety performance. Health staff contribute to the development of the relevant HSE policies and information systems, as well as provide safety training. This safety culture requires a high level of management commitment, policies, rules and procedures, incentives, training, communication and workers' involvement. These would result in a high score of employees' perceptions about their safety compliance and safety participation (Boughaba, Hassane, & Roukia, 2014).

According to Hong, Lin, Pai, Lai, and Lee (2004), "Petrochemical industry accidents are significantly associated with insufficient knowledge and unsafe behaviors of both employers and employees." Employees tend to have poor attitudes toward safety and health cognition and do not have enough training to manage their risks in the workplace. In addition, employees have low OHS knowledge and perception.

2.4.3 Participation in safety and health policy formulation

Occupational health and safety require an effective policy framework, to help guide decision-making and set future directions. Public health staff assist in establishing evidence-informed policies and can influence policy change. Primary prevention policies aim to prevent the incidence of disease or injury before it occurs but are less apparent in

many countries primarily due to competing social, economic, and political challenges (Veglia et al., 2016). For instance, a prospective health policy analysis would require examination of how various factors affect occupational carcinogen exposures and what can be done to reduce or prevent occupational cancer. Health staff can identify changes in the recognition of health effects and might prompt policies to safeguard workers' health and safety (Veglia et al., 2016). To promote a healthier environment, intensify primary prevention, and influence public policies to address the root causes of environmental threats to health, the health sector facilitates open, and multisectoral discussions. For instance, one of the World Health Organization's main legal instruments for regulating the prevention of acute chemical impact is the International Health Regulations (World Health Organization, 2014).

> "These require all countries to have systems in place for coordinating the management of events that may constitute a public health emergency of international concern, thus improving their capacity to detect assess, notify and respond to public health threats, including chemical threats. In addition, some World Health Assembly resolutions require the health sector to build capacity and implement measures necessary to prevent the negative health impacts of hazardous chemicals and wastes" (World Health Organization, 2014).

Swaminathan (2011) acknowledges that

> "the occupational health department has the most important role of anticipating emergencies, of preparing policies for how to deal with them at the local level, and of having an input into disaster planning. It follows that this important task can be undertaken only by occupational health professionals who are conversant with

what is going on within the plants for which they have a responsibility, and part of their duty must be to ensure that they keep up to date with any changes that take place. Those who do not have this knowledge are failing in their professional responsibilities."

Health Safety and Environmental issues should be included in the strategic management of the petrochemical industry. This is vital for sustainability in the national or international market. The HSE protection strategy requires the full participation of everyone in the industry supported with a strong desire for innovation.

Major criteria for strategy choice consist of selecting action plans linked with clearly understood objectives and targets especially those related to profit, health, safety and environment protection (Al-Sharrah & Elkamel, 2000). Public health staff are important participants in the process. The successful implementation of one or more of these strategies should help petrochemical plants to increase earnings and fit strongly in the current market.

Strategic management of chemicals and the environment led to the development of the Strategic Approach to International Chemicals Management (SAICM), so that, by 2020, petrochemical industry players will have minimized significant adverse impacts on the environment and human health. Health-sector involvement is significant in the development of such interagency plans and programs, considering its role in risk assessment, health impact assessment, monitoring, control and surveillance (World Health Organization, 2014). The Strategic Approach to International Chemicals Management (SAICM) outlines that the health sector has room to play a stronger role in

advocating action on chemicals and safer alternatives. This includes implementation of and compliance with legal instruments, standards, and policies.

2.4.4 Research and Development on Treatment and Solutions

The health sector has research centers that carry out investigations and provide expertise in the area of chemicals safety, such as the Russian Register of Potentially Hazardous Chemical and Biological Substances and the A.N. Sysin Research Institute of Human Ecology and Environmental Health (World Health Organization, 2014). These carryout researchers and give reviews on the effects of chemicals or combinations of chemicals on human health and the environment. It entails gathering clinical and research evidence about chemical risks and informing decision makers and the public (World Health Organization, 2014). According to Eyayo (2014)

> "Biological Monitoring/Medical Surveillance that involves periodic medical examination including pre-employment medical examination, health assessment, and biological test. Sickness absence monitoring, reporting of occupational diseases and illnesses and ethical and legal issues also fall under this role of the health staff."

This applied research is important because there is a long latency period between exposure and onset of side effects of harmful substances (Veglia et al., 2016).

The WHO's (2014) report on the health sector involvement states that

> "the health sector assesses the health risks posed by potential exposure to such chemicals during each of these phases and by occupational exposure, permitted industrial releases and discharges, waste disposal and the aftermath of acute chemical incidents and events (both accidental and deliberate). Having identified

the hazards and assessed the risks, health-care professionals have an important role to play in helping to mitigate or prevent the risks of exposure, thereby protecting public health. This process provides health-sector input into preventative measures, such as environmental planning and environmental permissions, policy development and implementation, legislation development and regulation, waste management and emergency planning and preparedness".

The health sector brings together stakeholders who are interested and committed to upholding OHS in the petrochemical industry. It is essential that such issues be dealt with through the coordination of agencies who share responsibilities in the broad area of environmental health (World Health Organization, 2014). They work with other sectors to advocate action on chemicals and safer alternatives. Health professionals from national and regional institutes of public health; involved organizations and interested individuals interact and share ideas and experiences with the aim of creating knowledge and generating the application of their findings (World Health Organization, 2014). It is, therefore, the responsibility of health staff to improve consultation, communication, and coordination with other sectors and increase the number of joint actions at the national, regional and international levels. This strengthens coordination, leadership and coherent action by international agencies, including United Nations agencies, relevant convention secretariats, multilateral funding agencies and regional development banks, with regard to the implementation by the health sector (World Health Organization, 2014). The role of the health sector in chemicals management is very broad and, therefore, health-care and public health professionals, as well as policy-makers in the health sector, should be invited to share their expertise by participating in relevant projects.

Therefore, the health sector plays a significant role in the development of interagency policies and programs on the occupational health and safety management of petrochemicals. It is evident that the contribution of the health sector to the petrochemical industry is valuable.

2.4.5 Steps Needed to Improve the Efficiency of OHS in the Petrochemical Industry

2.4.5.1 Development of effective courses and teaching methods on health and safety

To enable the development of a safety culture in organizations, appropriate course depth and suitable teaching methods are essential. Different work positions need different safety and health training courses and methods. Safety and health education are an efficient way to prevent occupational accidents, hence easing the work of health staff (Hong, Lin, Pai, Lai, & Lee, 2004).

2.4.5.2 Improvement of technology

The power of technology can be harnessed to enable the effective implementation of many OHS initiatives (Meswani, 2008). Potential disease risks can be reduced, and public health expenses substantially lowered by carrying out more comprehensive assessments and using better testing methods (World Health Organization, 2014). This report further states that

> “the development and implementation of sound chemicals management systems would significantly improve the collection and dissemination of information, including that on the health effects and other health-related aspects of chemical safety. The main problem is the collection of information in developing countries

and countries with economies in transition because of a lack of monitoring systems and technical and human resources. The development and implementation of sound chemicals management systems, including the collection of information on the health effects and other health-related aspects of chemical safety, would improve information collection and dissemination significantly."

For instance, Swaminathan (2011) points out that "In the field of toxicology, the existing methods of biological monitoring of exposure should be validated and methods for additional chemical substances should be developed." The reason being is biological monitoring is easily translated into health risks. Another statement mentioned by Swaminathan (2011) was that, "There is a still a long way to go to develop human biomarkers for use as hazard indicators, e.g., in cancer research. Epidemiologic studies of work-related cancers demand much more valid and detailed exposure data than hitherto." Focusing on the rapid growth of technology, it is safe to say human race is not far from developing human biomarkers to detect hazard indicators.

2.4.5.3 Strategic Management Approach to Health and Safety issues

One problem in this field is that some industries are not encouraged to initiate and implement health, safety, and environmental strategic tools. There are many reasons responsible for this; key among them are a lack of awareness and the fear of applying modern designs that have not been implemented before. The industry can face these problems easily since it can measure health, safety and environmental performance in several different ways that range from compliance with existing internal standards and applicable regulations to the amount of emissions, to environmental costs to hazard indices (Al-Sharrah & Elkamel, 2000).

2.4.5.4 Provision of a Strong Financial Base

Financial support for health sector involvement in the petrochemicals industry is very important. Countries' health sectors should have dedicated financial resources for the implementation of international chemical agreements and policies (World Health Organization, 2014). The report states that in many countries, public and environmental health units in ministries and national public health scientific institutions receive financial support from government budgets. This means that if chemical safety was recognized at the national level as a priority for public health activity, some degree of financial support would be available. Thus, several possibilities exist for raising funds for health-sector involvement in chemicals management, including national and international resources such as national budgets, international research projects and programs (World Health Organization, 2014).

2.4.5.5 Aggressive Education of public health professionals on Effects of the Petrochemical Industry

Public health professionals are rarely educated in petrochemical safety. It is not often included in their education and training programs. According to the World Health Organization (2014), very few countries include environmental health and chemical safety in licensing programs. Intensive awareness-raising exercises will change the attitude of professionals regarding the effects of chemicals on human health and change their approach from the treatment of these effects to the prevention of them. To achieve this, the collection of information through different scientific research projects, and health risk and health impact assessments at the national and international levels, is of the essence.

2.4.5.6 Legal enshrinement of the role of the health staff

Definition of the roles and responsibilities of the health sector in national legislation would enable the identification of overlapping mandates and gaps in regulations and enhance coordination among national agencies (World Health Organization, 2014).

> "Health-sector responsibilities and duties are not usually identified or recognized in legislation pertaining to other sectors (including that for the environment). To ensure recognition of the health sector's role in managing chemicals at all stages of their life-cycle, its responsibilities and functions should be clearly defined in legislation related to chemical safety. In some countries, for example, the Russian Federation, Thailand, and Uzbekistan, requirements for chemicals management are included in a national public health or other relevant act, as well as in the legislation of environmental and other agencies. Separate government decisions establish the responsibilities of the health sector in the area of environmental health, including the regulation of chemicals. This is important because it will create coherence between the mandates of the ministries with respect to their specific responsibilities. It will also facilitate capacity building and the development of scientific research in the health sector; encourage fund-raising in support of the health sector; and increase the sector's involvement in petrochemicals management." (World Health Organization, 2014)

Responsibilities and duties pertaining to health-sector is crucial as it deals with managing chemicals at all stages of their life and knowing the importance of this can help government establish necessary health sectors.

2.5 Role of Safety Culture Management System

“Safety culture” is term that was first used after the Chernobyl disaster in 1986. The report by the International Nuclear Safety Advisory Group (INSAG) of the International Atomic Energy Agency (IAEA) highlighted that “poor safety culture” as one of the contributing factors that led to the worst nuclear power plant accident in history. Even though the concept of safety culture has been used in numerous accounts in safety research especially in high-risk industries like oil, gas, chemical, nuclear and construction industries etc., little research has been done to examine the relationship between safety culture and safety performance (Thaden, Mitchell, Sharma., & Zhang, 2003). Recently, there have been many industries that have showed a growing interest in safety culture as an approach and means of potential disaster risk reduction in relation to associated unforeseen working conditions (Cooper, 2000). Safety culture is essentially the main indicator of safety performance (Guldenmund, 2000).

Safety culture is a complex concept that requires the needed for empirical and theoretical clarification (Wilpert, 2001). There are several definitions attributed to safety culture concept (Carroll, 1998). Most of these are however implicit and wide ranging and implicit. Safety culture has been defined as the result of the interactions between people (psychological factors), the organization (situational factors) and jobs (behavioral factors) (Cooper, 1998). Safety culture recognizes this tripartite interaction and is additionally represented by the definition Advisory provided by the Committee on the Safety of Nuclear Installations (Fernández-Muñiz., Montes-Peón., & Vázquez-Ordás, 2007).

The safety culture of an organization in accordance to Cooper is regarded as being made up of’ perceptions, attitudes and faiths of individuals, the safety management systems, their behavior as well as situational objective characteristics (Cooper, 2000).

Fernández-Muñiz et al (2007) consider culture of safety as a vital component of an industrial culture that refers to the individuals, the industrial structure and the work characteristics which have the potential of influencing health and safety. The role of a positive safety culture is to establish an atmosphere where employees know the risks they are exposed to in the workplace and how best they can protect themselves. The safety management culture is a significant tool that can be relied upon to check attitudes, faiths and behavior of the employees in relation to safety concerns.

In accordance to (Lefranc, Guarnieri,. Rallo., Garbolino,. Textoris., & 2012), safety culture is made up of three major components: behavioral, psychological and organizational. There is a consensus that contextual and organizational factors are important in safety culture. The psychological component is essential as it helps in the analysis of perceptions and attitudes of both individual and groups. The behavioral component on the other hand evaluates external factors like (following operating procedures, wearing Personal protective equipment (PPE), etc.), these are applicable to observable behavior and individuals in the field. Finally, the organizational component is related to the analysis of business operations through its structures, policies, and procedures.

Even though numerous factors have been found to underlie safety culture, the most common factor measures are regarded as safety rules, policies and procedures, communication, incentives, training, safety mangers, worker's involvement, commitment, and employees' safety behavior. Similarly, the dependence relations among these dimensions influence the concept of safety culture management.

Although the traditional measurements of safety performance focus on some form of injury or accident data, safety-related behaviors like safety participation and safety compliance can also described as the components of safety performance. Safety compliance therefore represents the behavior of the employees in ways that increase their personal safety and health. Safety participation represents the behavior of employees in ways that increase the safety and health of co-workers and support an organization's stated goals and objectives (Hagan, Montgomery, & O'Reilly, 2001).

In accordance to Griffin and Neal in a study that conceptualized employee safety performance as a bidimensional, it was suggested that employee safety performance can be distinguished as two types of safety behaviors: safety participation and safety compliance. Safety compliance refers to the behaviors aimed at meeting minimum safety standards at work, which includes, wearing required protective equipment and following safety procedures. Safety participation on the other hand refers to the behaviors that support workplace safety like voluntarily attending, safety meetings, or helping coworkers with safety-related issues. Safety participation and safety compliance have two parallel types of general work performance, which are contextual performance and task performance (Griffin & Neal, 2000).

Represented by the Sonatrach group, the Algerian petrochemical industry plays a significant role in the current global economic environment. Hence, the industry’s safety performance is of immense importance. Between the years 2004 to 2006, the sector witnessed numerous accidents including the GL1k and Nezla 19 which were both classified as some of the most significant accidents in the petroleum industry. These accidents revealed significant gaps in prevention plans. This influenced business

managers to set in place prevention plans and to change the management system of Health, Safety and the Environment (HSE) and a new policy HSE was organized in 2006.

In recognition of the crucial role of safety culture in preventing and controlling outcomes like fatalities, injuries and other incidents, this research aims at assessing the role of safety culture management in the petrochemical industry and to produce specific recommendations towards the realization of sustainable improvement of successful HSE (Boughaba, Hassane., & Roukia, 2014). A comparative analysis of two Algerian petrochemical industries; SH/DP/HRM and SH/BP/STATOIL found out that a positive safety culture is regarded by employees as scoring high in terms of management commitment, rules and procedures, policies, incentives, communication, training, and workers' involvement, etc. Such a positive safety in addition has the potential of resulting in better safety performance, for instance, most of the employees placed high scores on safety participation and safety compliance (Boughaba, Hassane., & Roukia, 2014).

SH/DP/HRM is a Sonatrach company DP Hassi R' Mel that is situated 525 km south of Algiers with its field spreads out over more than 3500 km^2 giving it a record of one of biggest gas fields in the world. SH/BP/STATOIL on the other hand is located in the Amenas gas field in eastern central region of Algeria. These operate in partnership between Algerian state oil company, Statoil (a Norwegian firm) and Sonatrach, British Petroleum (BP). SH/BP/STATOIL (Company A) has Algerian-European staff, whereas SH/DP/. HRM (Company B) is composed of purely Algerian workers (Boughaba, Hassane., & Roukia, 2014). Both companies have approximately similar sizes with roughly 3000 employees. The comparison between two petrochemical plants of the group Sonatrach confirmed results that the Norwegian ad English managers of Company A,

distinguish themselves by their mature safety culture in comparison to the lower evaluations of Company B in relation to their safety management practices and safety performance.

This study provided a confirmation on the definition of the safety culture concept, which is made up of a recognition of manager's commitment, the safety management system and employees involvement as major indicators. Furthermore, the study highlights the significant role of the safety culture as a key determinant for safety performance in the workplace. The study also emphasized on the crucial influence of managers' commitment to safety in determining the behavior of employees towards safety and consequently in occupational accident rates. This observation confirmed results from a study by Zohar (2000), who established that companies that have the lowest levels of occupational accidents are the ones with where top managers are personally involved in the routine measures of ensuring safety within the industry.

In accordance to a study by Fernández-Muñiz et al (2007), the commitment of managers is expressed by behavior and attitude and the show of constant interest in the working conditions of their employees and getting involved in the activities of santé et sécurité au travail (SST) as well as through the implementation of best safety practices. The company therefore has to work towards the implementation of a safety policy that reflects the values and principles of the industry that are in favor of the SST; motivate the SST activities; establish clear safety procedures and rules; supply employees with in-service training to ensure that they can work well with safety measures set in place; as well as to inform the workers concerning the risks to which they are exposed and to effectively correct and dispute them. The workers consequently become aware of the

significance of SST to ensure that they respect the procedures and the regulations of SST, offer suggestions to improve the SST and participate actively in the meetings.

Findings from the study are in support of the observation that a safety culture that supports the SST is closely linked with less accidents in comparison with industries that failed to pay attention to safety culture. The studies of Hofmann and Stetzer (1996) and Neal et al (2000) as well as that of Neal and Griffin (2006), suggest that workers who are committed to safety practices experience better performance aimed towards the overall reduction of occupational accident rates.

2.5.1 Strategic Safety Management

A strategic safety management system is a continuous and systematic process that is based on the proactive identification of workplace hazards and an analysis of their respective risks. The implementation of a safety management system is the most effective way of allocating the resources needed for safety because it not only helps to improve working conditions but also helps to positively influence the attitudes and behaviors of employees in relation to safety climate. Safety in the petrochemical industry is of great significance because it is an elevated risk and high energy plant with potentials for fire risks, explosion and poisoning. To meet market challenges, there is a need for petrochemical plants to work towards the provision of safe plant operations.

The safety design approach is used to ensure that safety is considered during the petrochemical industry design stage; this satisfies that safety will be considered during plant operation. To achieve safety, there is a need to analyze different industrial hydrogenation units through the HAZOP analyses which are summarized accordingly followed by the establishment of an intrinsic safety engineering design method for the

petrochemical plant. A safety design method helps to solve problems existing in HAZOP analysis report results in consideration to design, construction and empirical knowledge among others. In addition to initial traditional methods, databases are made and managed to direct safety engineering designs and ensure the realization of the intrinsic safety for the plant. The intrinsic safety of the petrochemical plant relies on the use of technological measures to control or eliminate risks as well as to prevent accidents and effectively avoid damage and losses. The application of this method is therefore important to help identify problems present in design on-order to avoid errors and omissions. It also helps to make up for lacking design experience and analysis needed to improve the efficiency of the design.

2.6 Corporate Social Responsibility: OHS and Sustainability

The three pillars of environment, society, and economy are frequently used to model how sustainability can be incorporated into an organization's mission, goals, and practices. To date, the environmental community has effectively leveraged the sustainability movement to advance improvements in environmental outcomes, such as resource usage and emissions reductions, through increased awareness, the establishment of a collective vision, investment in innovations, and promotion of transparency (Taubitz, 2010). The issues that are most often classified under the social sphere of sustainability (e.g., OSH, human rights, labor relations, community engagement, diversity, equity, benefits and compensation, the organization of work, supply chains, culture) are less understood and have gained less attention. This has led to people soloing sustainability; using the concepts of "environmental sustainability" and

“social sustainability” rather than an integrated vision for sustainable outcomes. This singular focus on any one aspect of sustainability can result in unintended negative impacts (e.g., hazards to workers arising from improvements to reduce environmental impacts) or creating tension between goals (e.g., labor and environment). Although there are many worker issues embedded within the concept of sustainability, there is a unique opportunity to advance OSH through this framework. Fully articulating and integrating OSH within sustainability efforts can help expand the thinking of those already involved in sustainability and provide a platform for OSHA and the community of safety and health professionals to move beyond traditional roles. Given the traction and the momentum of the sustainability movement, this type of engagement can be used as a transformative force to amplify the impact on the lives of workers, both inside and outside the workplace (Taubitz, 2010).

Sustainability is employed most generally to explain environmental considerations that are a necessity to reduce ecological harm and preserve natural resources. In its 1987 report “Our Common Future,” the United Nations’ Brundtland Commission outlined the concept far more loosely as “meeting the requirements of this while not compromising the power of future generations to satisfy their own desires.” By that definition, sustainability sounds a lot like old-fashioned forward thinking. United Rentals, associate instrumentality rental company is one business that has embraced the concept (Vargas & Vargas, *Safety+Health Magazine RSS*, 2018). “Sustainability is a few business observances its fiduciary obligations in associate moral method – one that balances the requirements of all stakeholders,” aforesaid St. Patrick McCorry, vice president at safety consulting firm DEKRA Insight in Oxnard, CA. “That includes shareholders, customers, employees, the

communities within which it operates, and society at large." Occupational safety and health fits squarely within the social responsibility component, placing safety professionals at the heart of their employer's sustainability strategy.

The growth of this movement within the business world is obvious within the rise of property coverage, additionally referred to as company social responsibility or environmental, social and governance reporting. In a 2017 Survey of Corporate Responsibility Reporting, Chicago-based accounting firm KPMG found that 93 percent of the world's 250 largest companies already were engaging in this reporting (Vargas & Vargas, "Sustainability," 2018). The number of public firms that have subtle property reports and metrics in public out there on their websites is growing chop-chop. Today, property is concerning being clear and showing that we tend to care concerning our people's safety, concerning our environmental impact, etc. And that transparency must be matched with firm commitment to eliminating exposures for staff and for the setting (Vargas & Vargas, "Sustainability," 2018). Standards organizations like the worldwide coverage Initiative and therefore, the property Accounting Standards Board area unit taking this concept a step additional, pushing to incorporate sustainability measures into annual financial reports. In fact, KPMG found that 78% of the world's largest firms have already got adopted integrated coverage. This finding is critical because it suggests that investors regard property info as "material," or relevant to their investment decisions, said Kathy Seabrook – chair of the Center for Safety and Health property and founding father of firm international Solutions Iraqi National Congress (Vargas & Vargas, "Sustainability," 2018). In Mendham, NJ, companies currently will show their organizational credentials by touting their place within the rankings of the Dow-Jones Industrial Average Property

Indices, the monetary Times Stock Exchange's FTSE4Good Index Series and the Corporate Knights' Global 100. *In a Safety & Health's 2018 Job Outlook survey*, 59% of respondents said sustainability was part of the safety and health function at their organization. However, sources agree that a lot of safety professional's roles area unit restricted to contributory safety metrics for property coverage (Vargas & Vargas, "Sustainability," 2018).

The benefits of sustainability reporting to an organization goes internal and external. Internal benefits is increased understanding of risks and opportunities, streamlining processes, reducing cost and improving efficiency, Emphasizing the link between financial and non-financial performance, etc. External benefits is mitigating negative environmental, social and governance impacts, demonstrating how the organization influences, and is influenced by expectations about sustainable development (n.d.). In today's world, the conception of property is attracting goodly attention as several governments have integrated it in their economic development ways. According to the World Health Organization (Oct,1994), property development is outlined as a method to "meet the wants of the current world population while not inflicting adverse result on health and on the setting, and while not depleting or endangering the worldwide resource base, hence without compromising the ability of future generations to meet their needs." Sustainable development depends on many principles for framing its actions, several of which might be applied to activity health and safety. These principles embrace the requirement for attention to incline to the health and quality of lifetime of individuals, to the prevention of known risks and to the application of precaution when there is uncertainty about the risks. It may also be thought-about that activity health and safety

(OHS) and hindrance of injuries and diseases area unit problems concern with reference to property. One of the key elements within the socio-economic development of enterprises is its workforce and the necessity for it to be healthy, productive and intended. Occupational health and safety must be incorporated at intervals in the management and business arrange of organizations to require under consideration the very fact that the healthy production of materials, goods, and services will solely be achieved if the health, safety, and well-being of the operating population is ensured. Putting stress within the management set up on the protection of the human resources and on promoting health and establishing a security climate is a way of achieving property, (Vargas & Vargas, "Sustainability," 2018). Occupational accidents and diseases will have a significant impact on productivity, competitiveness, and reputation of enterprises. The overall prices, taking under consideration the human and money elements, can by far exceed the compensation costs (including indemnities and medical costs). The investments in OHS have both social and economic advantages for the enterprises and up to date economic studies and surveys have confirmed the advantages of a top-down approach to OHS on business productivity and competitiveness. Additionally, it's being recognized that activity health associated safety ought to be an associated investment instead of an expense which happens to be a key component of the management and business plan of the enterprises.

OSH and Corporate Social Responsibility (CSR)

Corporate social responsibility will influence development of activity safety and health management and contribute to integration of safety and health into overall company’s management. It is of importance when managing psychosocial risks. Various

instruments are created to support the implementation of company social responsibility into management practices, together with among different codes of conduct and differing types of steering and standards. Many of them are designed to develop activity safety and health management within the framework of company social responsibility. Occupational safety and health (OSH) cover issues related to the social, mental and physical well-being of workers. For many years these issues have been recognized as main aspects of corporate social responsibility (CSR), which is based on voluntary integration of social and environmental concerns into the company's decision-making. This has been expressed (directly or indirectly) in varied definitions and approaches to CSR developed within the last decades. Corporate social responsibility (CSR) is defined by the European Commission as a concept whereby companies integrate social and environmental concerns into their business operations and interaction with their stakeholders on a voluntary basis. In developed countries, the concept of CSR has developed tremendously during the past decade, leading the International Standardized Organization (ISO) to publish ISO 26000 in 2010. ISO 26000:2010 has seven core subjects, one being labor practices. (Occupational safety and health management and corporate social responsibility (CSR), 2013). Labor practices embrace health and safety at work, which is related to the promotion and maintenance of the highest degree of physical, mental and social well-being of workers and the interference of hurt to health caused by operating conditions (Kawashita, F., & Nagata, M, 2017).

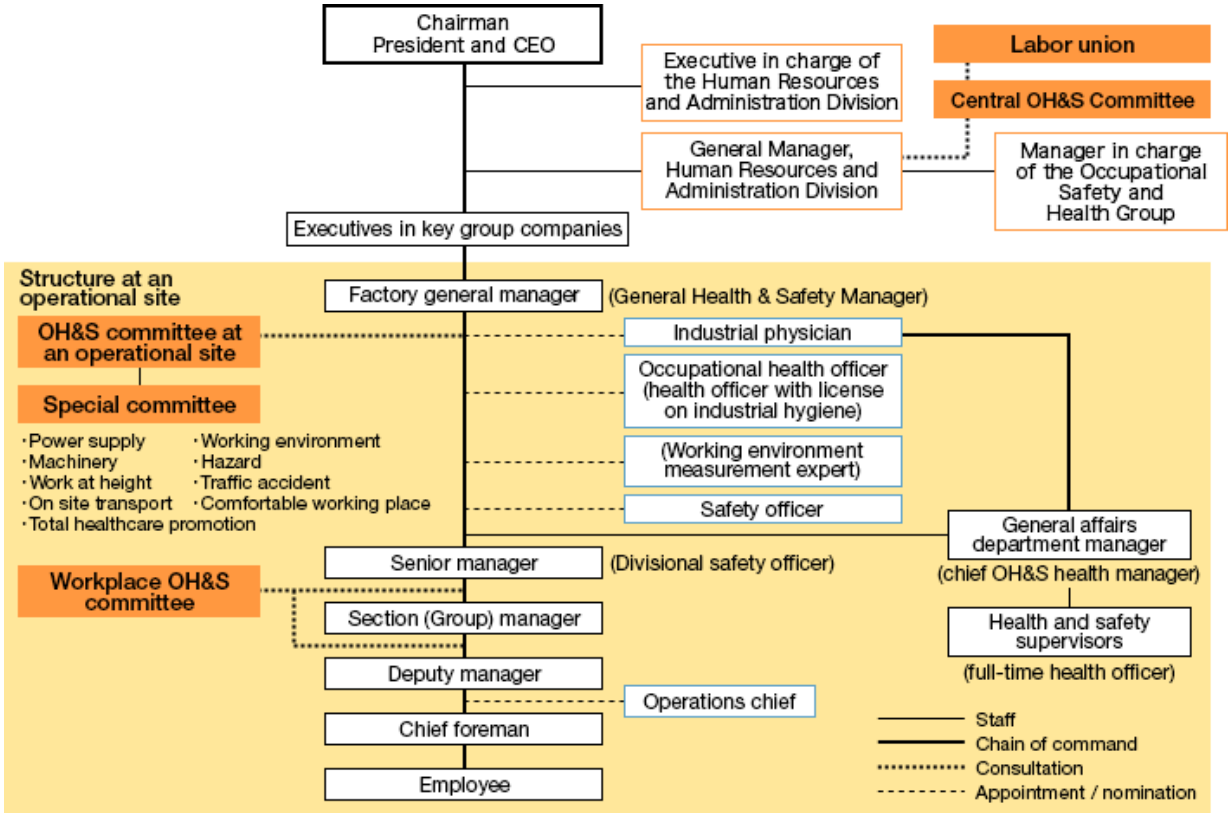
CSR is connected to activities of safety and health (OSH) in analysis practices. OSH is a very important side of CSR, as OSH is one among the indications want to live within company's overall progress in CSR. Several companies publish CSR-

related reports in booklets and other publicly available formats such as portable document format (PDF) files, which can be obtained from company website. This responsibleness mechanism needs the continuing implementation of CSR activities. Various pointers for reportage CSR activities are revealed, including the influential guidelines of the Global Reporting Initiative (GRI). GRI 2018 standard is the latest version of the GRI's Sustainability Reporting Guidelines. Companies use this document as a reference for developing CSR-related reports. GRI pointers advocate describing OSH activities like proportion of total personnel portrayed in formal joint management–worker health and safety committees that facilitate monitor and advise on activity health and safety programs, type of injury and rates of injury, occupational diseases, lost days, and absenteeism, and total number of work-related fatalities, and other activities relating to OHS (Kawashita, F., & Nagata, M, 2017). CSR could be viewed as an opportunity to integrate OHS aspects into a broader framework, or in other words, as an opportunity to address OHS questions beyond, and based on compliance with the legislation. CSR also may make the relationship between the firm's social concern and its reputation in the market more evident. OHS practitioners are launching initiatives aimed at presenting the firm's actions in a positive light, but CSR can show how to capitalize on these actions ("learning" effect) in the most efficient way. CSR allows business to deeply commit itself to workplace health, safety and welfare (Kawashita, F., & Nagata, M, 2017).

Below is a look at a company not included in the researched companies but contains valuable information to this research. The Toshiba group OHS management frame work as reported on the corporate social responsibility report, indicating compliance

to the GRI reporting standard in pointing out responsible parties to the implementation of OHS management in the organization.

Figure 2.1Toshiba Group OHS Management Structure from Toshiba sustainability report



GRI 403 - Occupational Health and Safety

The GRI 403: Occupational Health and Safety sets out reporting requirements on the topic of occupational health and safety. This Standard can be used by an organization of any size, type, sector or geographic location that wants to report on its impacts related to this topic. This Standard is part of the set of GRI Sustainability Reporting Standards (GRI Standards). The Standards are designed to be used by organizations to report about their impacts on the economy, the environment, and society. (Global Reporting Initiative 2018). The GRI standard comprises of 10 disclosures specific to each reporting topic, each of these standards also have subsections embedded in the topic to be reported. to better understand what the GRI standard entails, a summary of each disclosure is below;

Disclosure 403-1 Occupational health and safety management system

Recognized standards/guidelines for occupational health and safety management systems include international, national, and industry-specific standards. When reporting on the occupational health and safety management system, the organization can also describe; the type of occupational health and safety professionals responsible for the management system, and whether these individuals are employed by the organization or engaged as consultants; how the continual improvement of the management system is achieved, i.e., the iterative process of enhancing the management system to achieve improvements in overall occupational health and safety performance.

Disclosure 403-2 Hazard identification, risk assessment, and incident investigation

When describing the processes used to identify hazards and assess risks on a routine and non-routine basis, and to apply the hierarchy of controls, the reporting organization can: specify whether these processes are based on legal requirements and/or recognized standards/ guidelines; describe the frequency and scope of processes undertaken on a routine basis; describe the triggers for processes undertaken on a non-routine basis, such as changes in operating procedures or equipment; incident investigations; worker complaints or referrals; changes in workers or workflow; results of surveillance of work environment and worker health, including exposure monitoring (e.g., exposure to noise, vibration, dust); explain how obstacles to the implementation of these processes are removed for workers who might be more vulnerable to the risk of work related injury or ill health, such as workers facing language barriers or having visual or hearing impairments (e.g., by providing occupational health and safety training and information in a language easily understood by workers).

Disclosure 403-3 Occupational health services

Occupational health services aim to protect the health of workers in relation to their work environment. When describing how the quality of occupational health services is ensured, the reporting organization can explain whether the services are provided by competent individuals with recognized qualifications and accreditations, and whether it complies with legal requirements and/or recognized standards/guidelines.

Disclosure 403-4 Worker participation, consultation, and communication on occupational health and safety

When describing the processes for worker participation in occupational health and safety, the reporting organization can include information on: formal participation, based

on legal requirements; participation through engagement with formally recognized workers' representatives; direct participation, particularly by affected workers (e.g., the direct involvement of all workers in occupational health and safety decisions in small organizations); the use of committees, and how these committees are established and operated; participation in the occupational health and safety management system (e.g., participation in identification of hazards, assessment of risks, application of the hierarchy of controls, investigation of incidents, audits, decision-making about the use of contractors and outsourcing).

Disclosure 403-5 Worker training on occupational health and safety

When describing the occupational health and safety training provided, the reporting organization can include information on training and its delivery, how the effectiveness of the training is evaluated.

Disclosure 403-6 Promotion of worker health

Achieving universal health coverage, including financial risk protection; access to quality essential healthcare services; and access to safe, effective, quality and affordable essential medicines and vaccines for all, is one of the targets of the UN Sustainable Development Goals (Target 3.8).

Disclosure 403-7 Prevention and mitigation of occupational health and safety impacts directly linked by business relationships

A description of the organization's approach to preventing or mitigating significant negative occupational health and safety impacts that are directly linked to its operations, products or services by its business relationships, and the related hazards and risks.

Disclosure 403-8 Workers covered by an occupational health and safety management system

The reporting organization shall report on the number and percentage of all employees and workers who are not employees but whose work and/or workplace is controlled by the organization.

Disclosure 403-9 Work-related injuries

This disclosure covers work-related injuries. Data on work-related injuries are a measure of the extent of harm suffered by workers; they are not a measure of safety.

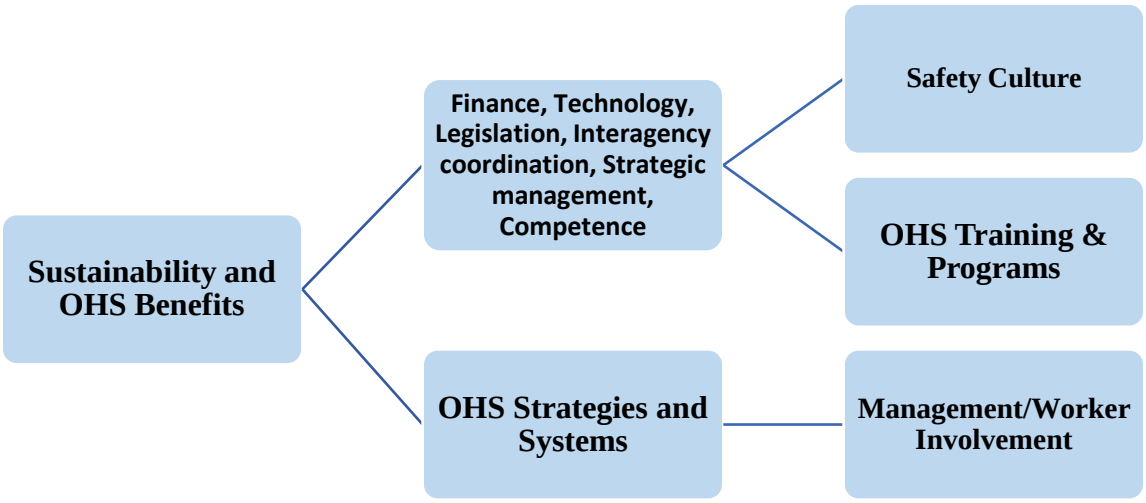
Disclosure 403-10 Work-related ill health

This disclosure covers all cases of work-related ill health notified to the reporting organization or identified by the organization through medical surveillance during the reporting period. The organization might be notified of cases of work-related ill health through reports by affected workers, compensation agencies, or healthcare professionals. The disclosure may include cases of work-related ill health that were detected during the reporting period among former workers. (Global Reporting Initiative 2018, p. 9 – 23).

2.7 Conceptual Framework

The operational framework for the study is presented in Figure 2 below.

Figure 2.2 Conceptual Framework



Chapter 3: RESEARCH METHODOLOGY

The researcher conducted a descriptive analysis of Corporate Social Responsibility (CSR) sustainability reports 2017/2018 given which is available for public viewing, from C&EN'S Global Top 50 Chemical companies. The selected companies were all petrochemical industries and data with the keywords used as the foundation of the research questions. The Global Reporting Initiative (GRI) was used as a guide revealing information on OHS components utilized by the selected industries as reported in the CSR.

The Global Reporting Initiative (GRI), established in 1997, developed a news framework that has become the foremost adopted model used for property news around the globe. Since its initial version, the framework has undergone several iterations to increase rigor and applicability. Using the proposed OSH Elements for Sustainability Reporting, adapted from CSHS Best Practice Guide for Occupational Health and Safety in Sustainability Reports, as a guide which encompasses the four performance indicators listed by GRI related to OHS:

1) Rates of injury, occupational diseases, lost days and absenteeism and total number of work-related fatalities by region.

2) Education, training, counseling, prevention and risk control programs in place to assist workforce members, their families or community members regarding serious diseases.

3) Percentage of total workforce represented in formal joint management-worker health and safety committees that help monitor and advise on OHS programs.

4) Health and safety topics covered in formal agreements with trade unions.

3.1 Population and Scope of the Study

Companies were chosen from C & EN'S Global Top 50 Chemical Companies found at https://cen.acs.org/business/finance/CENs-Global-Top-50-chemical/96/i31. The top 50 companies on this list were selected for this research. Published environmental and OSH components information was collected from the companies' sustainability reports (SR) or corporate social responsibility 2017/2018 (CSR) reports. The selection of these companies was based on the nature of the industry (petrochemical), the availability of a sustainability report following the global reporting initiative guidelines. The main tool used for analyzing the published data was content analysis, which is a "technique for making inferences by objectively and systematically identifying specified characteristics of messages." (Holsti,1969) A table below shows the 50 chemical companies and identified OHS components.

Table 3.1 50 chemical companies and identified OHS components

PETROCHEMICAL COMPANIES	IDENTIFIED OHS COMPONENTS
SABIC	Process Safety Inc rates, TRIR, Occ Illness Rate
BASF	Emergency response, Process safety, Distribution Safety.
Dow Chemical Co	Process Safety, Distribution safety.

Sinopec Group	Safety responsibility, safety behavior, safety training, risk management as well as management of hidden hazards, operations and occupational health.
Exxon Mobile	Emergency preparedness, Environmental performance
LyondellBasell	Occupational Safety, Process Safety, Supply Chain Safety, Occupational Health, Security and emergency management.
DuPont	Process safety, Safety and operation risk management
LG Chem	Process safety, product safety, behavioral/human factor safety, Supply Chain Safety.
Toray Industries	N/A
Inoes Holdings	Process safety, product safety, behavioral/human factor safety.
AirLiquide	Accident rates and analysis.
Mistibushi Chemical Co.	Implementation and Operation of Environmental Management Systems, Participation in Development of International Standards and Public Policy

Linde Group	A global system to record and assess incidents, including accidents, product leaks and near misses
Evonik Industries	Process safety, product safety, behavioral/human factor safety.
Covestro Co	Employee safety; accident records, incident investigation, Product Safety, Plant and process safety, Transport Safety
Akzonobel Industries	Process safety and Incident. Accident reports
Reliance Industries	Safety Culture, Implementation of Change Agents for Safety, Health and workplace Environment (CASHe)
PPG Industries	65% improvement in spills and releases rate from a 2017 baseline, 0 fatalities and a 6.5 percent reduction in our injury and illness rate
Braskem USA	Process safety, human factor, and performance safety
Solvay	Medical Treatment Accident Rate (MTAR): number of work accidents leading to medical treatment other than first aid per

	million working hours, Lost Time Accident Rate (LTAR): number of work accidents with lost time (away from work) of more than one day per million working hours.
Lotte Chemical	Increasing the awareness of safety to prevent accidents and actively carrying out the safety system enhancement and employee education/training to enable quick response.
Mitsui Chemicals	Management System
Shin-Etsu Chemical	Fundamental Safety Initiatives, Initiatives to Prevent Major Accidents, Major Accidents and Work-related Occupational Injuries, Safety and Prevention Training, Safety and Prevention Drills, Process safety and prevention plan, Reporting of accidents and loss time injuries, Training, environmental control and safety audits.
Praxair	Process safety, human factor, and performance safety

Yara	Process safety , Safety and operation risk management
Chevron Phillips Chemical	Process safety and prevention plan, Reporting of accidents and loss time injuries, Training, environmental control and safety audits.
Yara International	Total Recordable Injury Rate (TRIR), Process Safety, Environmental Safety.
Lanxess	Process safety , Safety and operation risk management
Bayer	Total Recordable Injury Rate (TRIR), Process Safety, Environmental Safety.
DSM	Safety Culture, Implementation of Change Agents for Safety, Health and workplace Environment (CASHe)
Ashasi Kasei	Process safety and prevention plan, Reporting of accidents and loss time injuries, Training, environmental control and safety audits.
Eastman Chemical	Emergency response, Process safety, Distribution Safety.
Arkema	Process safety and prevention plan.

Syngenta	Risk Management, Injury Rate, Environmental Safety.
BOREALIS	Process safety and prevention plan,
ECOLAB	Safety Culture, Implementation of Change Agents for Safety, Health and workplace Environment (CASHe)
Indorama Corp.	Safety, Sustainability, Social Responsibility
HUNTSMAN CORP.	Injury and Illness Rate, Process Safety Implementation Rate, Safety Training.
AIR PRODUCTS & CHEMICALS	Recordables and lost-time incident rates, Environmental Management, Risks and Compliance, Policies, programs and performance indicators for sustainability initiatives.
WESTLAKE CHEMICAL	Safety Programs, Injury rates
WANHUA CHEMICAL	Sustainability, Social Responsibility
SASOL	Training, Injury rate, Worker Involvement, Process Safety.

MOSAIC	Occupational health and safety programs, Type of injury and rates of injury, occupational diseases, Workers with high incidence or high risk of diseases, Safety Training.
PTT GLOBAL CHEMICAL	N/A
TOSOH	Process safety, product safety, human factor safety, Supply Chain Safety
DIC	Occupational health and safety programs, Safety Performance, Recordable Injury Rate, Process Safety.
HANWHA CHEMICAL	Emergency response, Process safety, Distribution Safety.
CLARIANT	Environmental Management, Risks and Compliance, Policies, programs
FORMOSA PLASTICS	Safety Performance, Recordable Injury Rate, Process Safety.

Once these OHS components were identified from the sustainability reports, using the OSH Elements for Sustainability Reporting, the research was able to highlight the effective OSH components used by these selected companies. Using the 2018 GRI

standards as a guideline for EHS/OHS reporting, we were able to identify these recommended responsibilities of the companies. These standards are as follows;

- Disclosure 403-1 Occupational health and safety management system
- Disclosure 403-2 Hazard identification, risk assessment, and incident investigation
- Disclosure 403-3 Occupational health services
- Disclosure 403-4 Worker participation, consultation, and communication on occupational health and safety
- Disclosure 403-5 Worker training on occupational health and safety
- Disclosure 403-6 Promotion of worker health
- Disclosure 403-7 Prevention and mitigation of occupational health and safety impacts directly linked by business relationships
- Disclosure 403-8 Workers covered by an occupational health and safety management system
- Disclosure 403-9 Work-related injuries
- Disclosure 403-10 Work-related ill health

GRI 403: Occupational Health and Safety sets out reporting requirements on the topic of occupational health and safety. This Standard can be used by an organization of any size, type, sector or geographic location that wants to report on its impacts related to this topic (GRI, 2018).

3.2 DATA COLLECTION

The data were extracted from the top 50 petrochemical company's sustainability 2017/2018 reports. These reports are reported voluntarily as part of the industry's corporate social responsibility (CSR) and may be found on the company's global website for easy accessibility. Given the nature of the newly edited GRI standard, which comes with segments attached to each standard, each standard and sub-standard was weighted in comparison to what has been reported by these 50 companies. These are the steps followed to arrive at each data:

Step 1- Access the company's corporate website or global website.

Step 2 - Browse through the content and locate sustainability, or a CSR report, a drop-down list of information will show either "environmental health and safety" or "safety" or just "sustainability." These were worded different on the reports.

Step 3 - Open the company's sustainability report. The file will open in a pdf format.

Step 4 - Compare the first standard and its sub sections to the selected company's report (e.g. GRI standard 403-1- Occupational health and safety management system) and evaluate whether the safety management report fully complies with the standard, if there is a partial compliance with the standard, or if the company failed to comply with any aspect of the standard. Select statements written to the effect of the GRI reporting standard fully utilizes examples of the company's compliance to the standard.

Step 5 - On a spreadsheet or a table, indicate with a “yes” if the company reports fully as required by the standard, “no” if the company does not report as required and “partial” if there is a statement of this requirement in the report.

Step 6 - Single out the identified codes (yes, no, or partial) and analyze the data collected from the reports.

Step 7- For statistical analysis, where there is no data or report, put a ‘NO’ to represent the absence of a report. On the singled out identified codes, yes responses will be 2, Partial will be 1 and No will be 0. *Note: these steps are not baseline for collecting data from sustainability reports, they are only custom fitted to this study.*

A spreadsheet was used to analyze the 50 selected companies to the GRI 2018 standard and its subsections. After careful observation of the standards and its subsections, it was revealed that some subsections of each standard were combined into one part of the standard resulting in the researcher incorporating more than one subsection into a column (e.g. 403-1a(i)(ii) Disclosure 403-1 Occupational health and safety management system). The reporting organization shall report the following information for employees and for workers who are not employees but whose work and/or workplace is controlled by the organization. A statement of whether an occupational health and safety management system has been implemented, including whether:

I. The system has been implemented because of legal requirements, and if so, a list of the requirements;

II. The system has been implemented based on recognized risk management and/or management system standards/guidelines and, if so, a list of the standards/guidelines.

An example is a company report from Air Products, “As noted in the Conserve section of this report, Air Products has a global EH&S Management System that applies to 100% of our locations worldwide. This system integrates corporate policies and governmental regulations, and supports the principles promoted by international standards such as Occupational Health and Safety Assessment Series (OHSAS) 18001. There are over 250 standards in our EH&S Management System, and the majority are related to safety and/or health”.

Chapter 4: RESULTS

4.1 Global Reporting Initiative (GRI)

The Global Reporting Initiative (GRI) mentions a CSR report that can be used both internally and externally. The report helps managers to structure a company's CSR work (Niskala et al., 2009). In our assessment of the CSR reports, for describing the occupational health and safety reporting of the top 50 global chemical companies according to C & EN, the 2018 Global Reporting Initiative standard 403 for Occupational Health and Safety was utilized as the criterion to determine the components. We utilized the 10 GRI standards to review the petrochemical company's annual sustainability reports in relation to occupational health and safety identified in the research, using a yes/no code to determine if these companies are reporting based on this criterion. Table 2 summarizes the 50 companies and the number of Yes, Partial, and No responses.

Table 4.1 Summary of Yes, No and Partial Responses of the top 50 Chemical Companies

PETROCHEMICAL COMPANIES	Yes Responses	No Responses	Partial Responses
SABIC	6	6	2
BASF	7	2	5
Dow Chemical Co	2	12	0
Sinopec Group	2	8	4
Exxon Mobile	7	5	2
LyondellBasell	2	10	5
DuPont	3	8	3
LG Chem	2	11	0
Toray Industries	-	-	-
Inoes Holdings	0	12	2
AirLiquide	-	-	-
Mistibushi Chemical Co.	1	11	2
Linde Group	-	-	-
Evonik Industries	1	7	5
Covestro Co	5	8	1
Akzonobel Industries	2	11	0
Reliance Industries	5	6	1

PPG Industries	1	11	2
Braskem USA	6	6	2
Solvay	-	-	-
Lotte Chemical	-	-	-
Mitsui Chemicals	4	6	2
Shin-Etsu Chemical	5	7	1
Praxair	-	-	-
Yara International	3	11	0
Chevron Phillips	2	9	3
Lanxess	-	-	-
Bayer Corp.	-	-	-
DSM	2	11	1
Ashasi Kasei	1	9	4
Lubrizol	2	11	1
Eastman Chemical	4	9	1
Arkema	2	11	1
Syngenta	-	-	-
BOREALIS	2	1	1
ECOLAB	5	1	7
Indorama Corp.	1	7	5
Huntsman Corp.	-	-	-
Air Products & Chemicals	6	1	7

WEST LAKE CHEMICAL	-	-	-
WANHUA CHEMICAL	-	-	-
MOSAIC	5	9	0
Johnson Matthey	7	5	2
Sasol	2	3	9
Tosoh	4	2	8
Hanwah Chemical	-	-	-
Clariant Corp.	3	2	9
DIC Corp.	2	8	4
SK Innovations	3	8	3
FORMOSA PLASTICS	-	-	-

The table above, contains responses mentioned above. For statistical data, yes responses were represented by *2*, no responses were represented by *1*, and partial responses were represented by *0*. An example will be SABIC;

Yes (2) - (6) – This refers to the total amount of “yes” responses, i.e. 6 number of times for reporting according to the GRI standards.

No (1) - (6) – This refers to the total occurrences of “no” responses, i.e. SABIC had reported no to the GRI standards 6 times.

Partial (0) - (2)- SABIC had 2 partial responses to the GRI reporting standard. “0” refers to partial responses.

Each company's sustainability report was carefully compared to the standards for OHS reporting guidelines and duly adhered to. Industries that had no report was indicated with a dash sign, reports that were incomplete had partial designations to that effect, full reports to every baseline of the standard designated with a yes, while those reports with no reports to specific standards were designated with "no". In total, 14 of the 50 companies didn't report using the global reporting initiative, although valuable information was available in their sustainability reports.

To further explain the results, frequency tables for each GRI standard were generated from the excel spreadsheet, when compared to each company's reporting in accordance to the global reporting initiative.

1. Disclosure 403-1 Occupational health and safety management system

Table 4.2 Frequency table of summarizing OHS element of GRI standard 403-1a (i)(ii)

	Frequency	Percent	Valid Percent	Cumulative Percent
No	16	32.0	32.0	32.0
Partial	8	16.0	16.0	48.0
Yes	26	52.0	52.0	100.0
Total	50	100.0	100.0	

a. A statement of whether an occupational health and safety management system has been implemented, including whether:

I. the system has been implemented because of legal requirements and, if so, a list of the requirements;

II. the system has been implemented based on recognized risk management and/or management system standards/guidelines and, if so, a list of the standards/guidelines.

Disclosure 1 of the GRI standard, which covers occupation health and safety management system had a response scale of 16 “no”, 8 “partials” and 26 “yes” from all 50 companies. i.e. From these results, it shows that 52% of the companies responded yes to reporting to the GRI standard 403- 1a(i)(ii), 32% of the companies did not report according to standard and 16% reported partially.

1. Disclosure 403-1 Occupational health and safety management system

b. A description of the scope of workers, activities, and workplaces covered by the occupational health and safety management system, and an explanation of whether and, if so, why any workers, activities, or workplaces are not covered.

Table 4.3 Frequency table of summarizing OHS element of GRI standard 403-1b

	Frequency	Percent	Valid Percent	Cumulative Percent
No	33	66.0	66.0	66.0
Partial	15	30.0	30.0	98.0
Yes	2	4.0	4.0	100.0
Total	50	100.0	100.0	

This disclosure covers the b part of the first standard, the scope of workers covered by the occupational health and management system. There's a total of 66% "no" reporting to the effect of disclosure b, a 30% "partial" reporting and 4% of "yes" reports from all 50 companies. This indicates a most of the companies do not report to this GRI disclosure listed above, while 2 companies reported according to the disclosure.

2. Disclosure 403-2 Hazard identification, risk assessment, and incident investigation

a. A description of the processes used to identify work-related hazards and assess risks on a routine and non-routine basis, and to apply the hierarchy of controls to eliminate hazards and minimize risks, including;

I. how the organization ensures the quality of these processes, including the competency of persons who carry them out;

ii. how the results of these processes are used to evaluate and continually improve the occupational health and safety management system.

Table 4.4 Frequency table of summarizing OHS element of GRI disclosure 403-2a

	Frequency	Percent	Valid Percent	Cumulative Percent
No	30	66.0	60.0	60.0
Partial	14	28.0	28.0	88.0
Yes	6	12.0	12.0	100.0
Total	50	100.0	100.0	

The frequency table highlights a 66% of the 50 companies that did not report as the disclosure implies, a 28% partial reporting rate and a 12% of those that reported according to the GRI disclosure 403-2a that covers the description of processes used in identifying work related injuries.

Table 4.5 Frequency table of summarizing OHS element of GRI disclosure 403-2a(i)

	Frequency	Percent	Valid Percent	Cumulative Percent
No	29	58.0	58.0	58.0
Partial	12	24.0	24.0	82.0
Yes	9	18.0	18.0	100.0
Total	50	100.0	100.0	

The frequency table highlights a 58.0% of the 50 companies that did not report as the disclosure implies, a 24% partial reporting rate and a 18% of those that reported according to the GRI disclosure 403-2a(i).

Table 4.6 Frequency table of summarizing OHS element of GRI disclosure 403-2a(ii)

	Frequency	Percent	Valid Percent	Cumulative Percent
No	36	72.0	72.0	72.0
Partial	10	20.0	20.0	92.0
Yes	4	8.0	8.0	100.0
Total	50	100.0	100.0	

The frequency table highlights a 72.0% of the 50 companies that did not report as the disclosure implies, a 20% partial reporting rate and an 8% of those that reported according to the GRI disclosure 403-2a(ii).

Table 4.7 Frequency table of summarizing OHS element of GRI disclosure 403-2(b)(c)(d)

	Frequency	Percent	Valid Percent	Cumulative Percent
No	42	84.0	84.0	84.0
Partial	8	16.0	16.0	100.0
Total	50	100.0	100.0	

One major observation on this table, will be the absence of yes responses, this occurred because none of the 50 companies reported the GRI disclosure 403-2(b)(c)(d). Another observation will be most companies did not report using the newly edited GRI disclosures. Highlights from the table are; an 84% of companies didn't report accordingly, and 16% only had a partial rate in reporting to the content of the disclosure.

3. Disclosure 403-3 Occupational health services

a. A description of the occupational health services' functions that contribute to the identification and elimination of hazards and minimization of risks, and an explanation of how the organization ensures the quality of these services and facilitates workers' access to them.

Table 4.8 Frequency table of summarizing OHS element of GRI disclosure 403-3a

	Frequency	Percent	Valid Percent	Cumulative Percent
No	35	70.0	70.0	72.0
Partial	6	12.0	12.0	92.0
Yes	9	18.0	18.0	100.0
Total	50	100.0	100.0	

The frequency table above, highlights the percentages of yes, no and partial responses, 70.0% of the 50 companies did not report as the disclosure implies, 12% had a partial reporting rate and an 18% of those that reported according to the GRI disclosure 403-3a(ii).

4. Disclosure 403-4 Worker participation, consultation, and communication on occupational health and safety

a. A description of the processes for worker participation and consultation in the development, implementation, and evaluation of the occupational health and safety management system, and for providing access to and communicating relevant information on occupational health and safety to workers.

b. Where formal joint management–worker health and safety committees exist, a description of their responsibilities, meeting frequency, decision-making authority, and whether and, if so, why any workers are not represented by these committees.

Table 4.9 Frequency table of summarizing OHS element of GRI disclosure 403-4(a)(b)

	Frequency	Percent	Valid Percent	Cumulative Percent
No	34	68.0	68.0	68.0
Partial	9	18.0	18.0	86.0
Yes	7	14.0	14.0	100.0
Total	50	100.0	100.0	

As the table indicates, 68% of the companies didn't report as subsection a and b requests, shedding light on the fact that the 50 companies have not begun reporting using the 2018 GRI disclosure of OHS reporting. 18% reported partially to both subsections while 14% had full reporting disclosure for 403-4(a)(b). This disclosure focuses on the company's responsibility to disclose worker participation and a formal joint OHS management system where workers, either contractors or regular employees can make "safety" contributions to the organization.

5. Disclosure 403-5 Worker training on occupational health and safety

a. A description of any occupational health and safety training provided to workers, including generic training as well as training on specific work-related hazards, hazardous activities, or hazardous situations.

Table 4.10 Frequency table of summarizing OHS element of GRI disclosure 403-5(a)

	Frequency	Percent	Valid Percent	Cumulative Percent
No	27	54.0	54.0	54.0
Partial	11	22.0	22.0	76.0

Yes	12	24.0	24.0	100.0
Total	50	100.0	100.0	

Just as the previous tables reveal how these 50 companies reported on safety training provided to workers. There was a 54% of the companies that didn't report as the disclosure implies, for partial disclosures, 22% of the companies reported, while 24% disclosed in completion the 403-5 GRI standard.

6. Disclosure 403-6 Promotion of worker health

a. An explanation of how the organization facilitates workers' access to non-occupational medical and healthcare services, and the scope of access provided.

b. A description of any voluntary health promotion services and programs offered to workers to address major non-work-related health risks, including the specific health risks addressed, and how the organization facilitates workers' access to these services and programs.

Table 4.11 Frequency table of summarizing OHS element of GRI disclosure 403-6(a)(b)

	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
No	22	44.0	44.0	44.0
Partial	9	18.0	18.0	62.0
Yes	19	38.0	38.0	100.0
Total	50	100.0	100.0	

The frequency table is combined with both subsections for disclosure 403-6, which focuses on the organization's disclosure of workers access to medical services and health programs. Thus, revealing a 44% of companies that did not disclose what the 403-6 entails, 18% had partial disclosures while 38% of the 50 companies reported according to the standard.

7. Disclosure 403-7 Prevention and mitigation of occupational health and safety impacts directly linked by business relationships

a. A description of the organization's approach to preventing or mitigating significant negative occupational health and safety impacts that are directly linked to its operations, products or services by its business relationships, and the related hazards and risks.

Table 4.12 Frequency table of summarizing OHS element of GRI disclosure 403-7(a)

	Frequency	Percent	Valid Percent	Cumulative Percent
No	33	66.0	66.0	44.0
Partial	7	14.0	14.0	80.0
Yes	10	20.0	38.0	100.0
Total	50	100.0	100.0	

Table 13 reveals the organizations reporting on approaches to prevent negative impacts to employees and its operations. From the 50 companies, the total percentage of companies that didn't disclose came to a tune of 66%, 14% had partial disclosures and 20% reported just as the 403- 7 suggests.

8. Disclosure 403-8 Workers covered by an occupational health and safety management system

a. If the organization has implemented an occupational health and safety management system based on legal requirements and/or recognized standards/guidelines:

i. the number and percentage of all employees and workers who are not employees but whose work and/or workplace is controlled by the organization, who are covered by such a system;

ii. the number and percentage of all employees and workers who are not employees but whose work and/or workplace is controlled by the organization, who are covered by such a system that has been internally audited;

iii. the number and percentage of all employees and workers who are not employees but whose work and/or workplace is controlled by the organization, who are covered by such a system that has been audited or certified by an external party.

b. Whether and, if so, why any workers have been excluded from this disclosure, including the types of worker excluded.

c. Any contextual information necessary to understand how the data have been compiled, such as any standards, methodologies, and assumptions used.

Table 4.13 Frequency table of summarizing OHS element of GRI disclosure 403-8(a)(b)(c)

	Frequency	Percent	Valid Percent	Cumulative Percent
No	37	74.0	74.0	75.5
Partial	8	16.0	16.0	91.8

Yes	4	8.0	8.0	100.0
Total	50	100.0	100.0	

Given the numerous subsections and requirements, sections a, b, and c were combined into one frequency table because the OHS disclosures (403-8), reported by the 50 companies were all embedded into one statement or description as indicated by the standard. Table 14 shows 74% of those companies didn't disclose accordingly, 16% had partial disclosures while only 8% did utilize the GRI standard.

9. Disclosure 403-9 Work-related injuries

a. This disclosure covers work-related injuries. Data on work-related injuries are a measure of the extent of harm suffered by workers; they are not a measure of safety.

Table 4.14 Frequency table of summarizing OHS element of GRI disclosure 403-9(a-g)

	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
No	42	84.0	84.0	84.0
Partial	3	6.0	6.0	90.0
Yes	5	10.0	10.0	100.0
Total	50	100.0	100.0	

There was a very high rate of companies not disclosing as the standard suggests, but reading through the GRI dockets, the GRI sustainability reporting is completely voluntary for organizations to give full disclosures on these standards. Thus, reporting for

403-9 was at high low of 84%, while 6% only had partial disclosures, which further reveals the voluntary full disclosure of the standard and 10% of the companies reported in detail, the statements in the disclosure. Types of work-related injury were also included in these reports, such as lacerations, loss of limbs and minor fractures. An example is BASF reporting on work related injuries; In 2017, 1.4 work-related accidents per one million working hours occurred at BASF sites worldwide (2016: 1.5[2]), reducing the proportion of chemical-related accidents to 5% (2016: 9%). The rate of work-related accidents for contractors was at 1.5 in 2017 (2016: 1.5). Unfortunately, there were two fatal work-related accidents in 2017. In 2016, four incidents occurred with a total of eight fatalities (seven in the same year). BASF is performing a comprehensive analysis of the incidents and using the findings to derive appropriate measures.

10. Disclosure 403-10 Work-related ill health

a. The standard for 403-10 request the reporting organization shall include fatalities as a result of work-related ill health in the calculation of the number of cases of recordable work-related ill health.

Table 4.15 Frequency table of summarizing OHS element of GRI disclosure 403-10

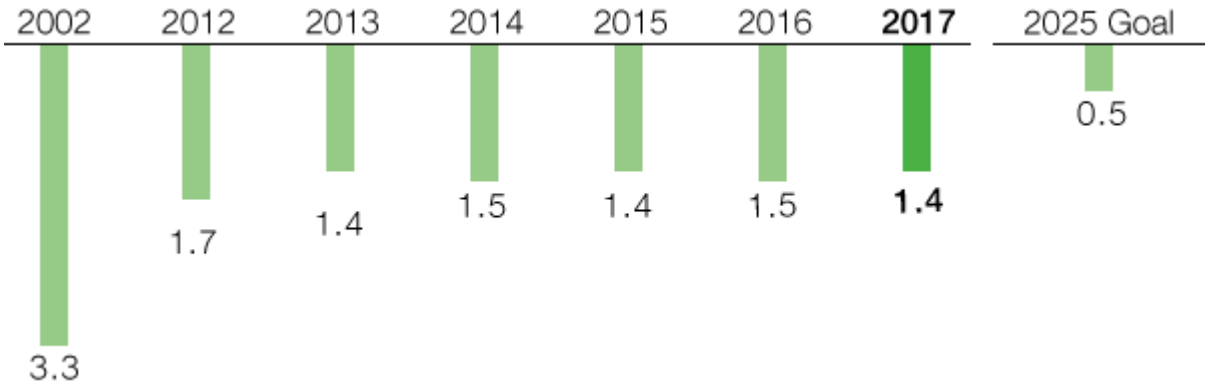
	Frequency	Percent	Valid Percent	Cumulative Percent
No	31'	62.0	62.0	62.0
Partial	6	12.0	12.0	74.0
Yes	13	26.0	26.0	100.0
Total	50	100.0	100.0	

Table 16 further reveals each company's disclosure of the sustainability reporting standard, with an 62% of the companies that didn't report as requested, 12% reported partially while 26% of the company population disclosed as the standard indicates. Judging from the results from each frequency table, we can see that frequency of "no", responses to the GRI sustainability report standards, range from 44% - 84%, while companies with yes responses ranged from 4% - 28% which is low outcome when compared to what organizations should disclose in the sustainability reports, while companies with partial reporting ranged between 6% - 30%. BASF reports in 2018, "we will adapt our reporting on accidents and process safety incidents to the recommendations of the International Council of Chemical Associations (ICCA), the European Chemical Industry Council (CEFIC) and the German Chemicals Industry Association (VCI). To implement these recommendations, we also must convert our targets. Consequently, our goal from 2018 onward is to reduce occupational and process safety incidents to a rate of no more than 0.1 per 200,000 working hours by 2025 (previous goal: a rate of no more than 0.5 incidents per one million working hours)".

The 2016 figure has been restated as against the previous year's report from 1.4 to 1.5 due to retrospective accident reports.

4.1.1.1 Lost-time injury rate per one million working hours

Figure 4.1 Lost time injury rate per one million working hours(BASF SR, 2018)


2002
2012
2013
2014
2015
2016
2017
2025 Goal
3.3
1.7
1.4
1.5
1.4
1.5
1.4
0.5

Chapter 5: DISCUSSION AND CONCLUSION

5.1 DISCUSSION

The GRI sustainability reporting serves as a guide for organizations to strengthen their OHS responsibilities across the organization. These standards are designed to be used by organizations to report about their impacts on the economy, the environment, and society. In addition to preventing damage, an organization can promote workers' health by offering healthcare services or voluntary health promotion services and programs, which, for example, may help workers improve their diet or quit smoking. These are just a few benefits of utilizing the GRI sustainability reporting standard. This paper analyzed the OHS global reporting of 50 petrochemical companies. The case companies all represented the oil and gas industry. These results showed that the case companies' OHS reporting consisted of the 10 global reporting disclosures such as occupational and health management system set up by the organization, showing the involvement of every responsible team or individual in the OHS division of the company, reporting of workers ill health related cases, workers injury rate and promotion of workers health. In the context of the GRI Standards, the social dimension of sustainability concerns an organization's impacts on the social systems within which it operates. GRI 403 addresses the subject of activity health and safety. Healthy and safe work conditions are recognized as a human right and addressed in authoritative intergovernmental instruments, including those of the International Labor Organization (ILO), the Organization for Economic Co-operation and Development (OECD), and the World Health Organization (ILO-OSH, 2001).

Healthy and safe work conditions also are a target of the property Development Goals, adopted by the United Nations (UN) as part of the 2030 Agenda for Sustainable

Development. Healthy and safe work conditions involve both prevention of physical and mental harm, and promotion of workers' health (ILO-OSH, 2001). An occupational health and safety management system, as defined by the International Labor Organization (2001), is a set of interrelated or interacting elements, utilized to establish an occupational health and safety policy and objectives, and to attain those objectives. Disclosures of industry's OHS management system was generally implemented by the 50 companies. Taking a closer look at the results from disclosure 403-1, 26 of the companies implemented an OHS management system that yielded a 52% rate of positive responses to the effect of the disclosure, with 16 undisclosed information on an OHS system in the organization, and 8 only reported partially to the disclosure. Because global reporting in full disclosure or partial, is completely voluntary, which was observed from the various sustainability reports. The company's reports were focused on occupational safety with a variety of subareas, whereas reporting of disclosure 403-2 Hazard identification, risk assessment, and incident investigation; 403- 2(a)(ii), was seldom reported just as disclosure 403-8 workers covered by an occupational health and safety management system. This does not necessarily mean the reporting company doesn't have workers covered by the OHS system or internal reports on disclosure 403-2. In each disclosure reported, these companies reported processes implemented that had yielded positive results inclusive of the future goals to reduce accidents and injuries, also improved safety training and process safety. The data revealed that very few companies are reporting in full, the OHS information using the GRI standard. The oil and gas firms reporting were limited when compared to the available global reporting initiative guidance document. It appeared that OHS reporting was not a crucial factor to external sustainability reporting,

it was more business information and environmental effects linked directly to their operations is not an important factor in external sustainability reporting. However, these guidance documents do not appear to be widely used by these oil and gas companies although other contents of the topic-specific GRI Standards; 200 (Economic topics), 300 (Environmental topics), and 400 (Social topics), were reported as the standard proposes. Some companies did not disclose some information on OHS in full using the global reporting initiative. Further analysis into the results, also revealed some of the 50 companies didn't disclose full information on work related injuries or fatalities, disclosures that were most reported on an OHS management system. GRI's framework for sustainability reporting helps these companies identify, gather and report information relating to OHS, in a clear and comparable manner. The standard requires companies to disclose the GRI 403: Occupational health and safety standard, as part of their social responsibilities to improve safety concerns. Future studies will be to further examine the benefits of OHS reporting to companies other than oil and gas, by discussing with individuals that make up the occupational safety management system in the organization. The research revealed useful tips from the GRI in respect to OHS;

- Enables organizations to communicate their efforts to prevent harm and to promote workers' health in the organization.
- Covers the full spectrum of workers for whose occupational health and safety the organization is expected to be responsible.
- Includes leading indicators such as implementation of an occupational health and safety management system and active engagement of workers.

- Places emphasis on identification of hazards and assessment of risks, and the application of hierarchy of controls.
- Helps measure impacts on the health of workers as opposed to measuring the loss of productivity for the organization.
- Includes improved methodologies for measuring and reporting work-related injuries and ill health.

The baseline for this research is that organization's that utilize the global report initiative, can be better equipped in handling safety issues by disclosed information from other companies in the same industry. The researcher would want to interact with professionals in an OHS management system, to find those who implement the GRI standards as part of their corporate social responsibility and organizations that do not disclose using the standard. Comparing these responses will help the researcher better explore how much emphasis is put on mitigating safety issues that directly affect workers directly from the industry's operations. The researcher will encourage companies to utilize the GRI standards because of the OHS importance as listed above. Doing this also keeps these companies responsible for employee safety and by reporting, they reveal valuable information that can help better safety performance. The GRI is based on corporate sustainability reports that must be inclusive of sustainability context relating to OHS, environmental impacts should be reported, and social impacts relative to employees. The GRI is also aligned with key international instruments from the International Labor Organization (ILO) and with ISO 45001, that can gear industries into improving safety based on the instruments highlighted as guidelines for safety performance.

5.2 CONCLUSION

Content analysis of the sustainability reports from the 50 oil and gas companies indicated that they made reasonable efforts to disclose their OHS performance in accordance with the GRI Sustainability Reporting Guidelines. These guidelines appear to provide a robust and readily available tool for reporting comprehensive progress concerning all aspects of environmental activities. The adoption of the guidelines by a vast majority of the oil and gas companies increases transparency, credibility, and comparability in sustainability reporting. Governments and professional bodies should support the adoption of these international reporting standards, and third-party assurance adds value or credibility to the reports of those companies that have adopted it. Lagging OHS indicators are those associated with measurements after an accident occurs, such as injury rates, experience modification rates, accident costs, etc. This was generally seen to be reported by these companies, and they are reactive measurements that reflects upon the concept of safety I, a traditional view of safety practiced widely among various organizations. Examples of these indicators used by 50 companies are; incident and injury rate, days away from work, etc. Leading indicators which concentrate on preventive measures add future performances of the organization. This approach emphasizes the importance of employees reporting improvement that have been observed. These leading indicators are otherwise known as activity-based and proactive measures, and if utilized adequately, could improve safety issues within the company. Companies such as SABIC, BASF, and Dow revealed useful information on the outcome of utilizing leading indicators. An excerpt from the Dow 2017 report, showing how the indicator was implemented; To meet its goal and to eliminate all preventable Motor

Vehicle Accident Fatalities, Dow will introduce telematics devices in all company owned or leased vehicles by January 1, 2019. These devices will help to improve safety and skills by alerting the driver when the speed limit in force is temporarily exceeded, when harsh acceleration, braking or cornering is observed or when a lane-handling deviation occurs. In 2017, Dow also banned employees and contractors from accepting incoming or outgoing cellphone calls while driving, even if a hands-free system such as Bluetooth is used" (Dow SR, 2017) Health and safety at any workplace is everyone's responsibility, employees who pay attention to safety measures and reports positive observations, the frequency of negative incident diminishes. The relationship between these values could serve as a leading indicator that could be valuable to the organization. Each organization can take a more proactive approach instead of a reactive action just by utilizing the leading indicators as the companies above have shown. Further analysis into the results, also revealed some of the 50 companies didn't disclose full information on work related injuries or fatalities, disclosures that were most reported was that on an OHS management system. GRI's framework for sustainability reporting helps these companies identify, gather, and report information relating to OHS in a clear and comparable manner. Every day, occupational accidents or work-related diseases incapacitate or kill workers, at great human cost. And the economic cost is also high for businesses, regardless of their size or sector. The International Labor Organization (ILO), estimates the economic burden of poor occupational safety and health practices at close to 4% of global GDP each year. This means occupational health and safety is a pressing challenge for business globally. But information on worker health and safety is often incomplete, difficult to compare, and focuses on measuring past incidents and the resulting loss of productivity

for the business, there is a critical need for reliable and comparable occupational safety and health data and indicators that not only inform action but also drive action that we know improves occupational safety and health performance and advances sustainability. With the GRI 403: Occupational Health and Safety 2018, companies are now better able to measure how they contribute to the health, safety and general wellbeing of their workers. The Standard has been revised to focus on the presence of robust occupational health and safety management systems, and the processes and programs that prevent harm and promote worker health and will assist companies in driving improvements in occupational health and safety and in the lives of millions of workers through transparency (GRI, 2018). Initiatives for promoting CSR are predominantly private and voluntary, while OSH initiatives are often dominated by legal regulation and governmental action. Since OSH legislation in the developing world is either lacking or non-existent in many countries, it seems logical to promote OSH through other measures based on the strong business and economic case to support it and was the key objective of the CSR-OSH project. CSR has the merit of providing a broad space for the development of innovative approaches to a whole variety of issues, according to economic and market circumstances, but also as a means of preparing or 'softening up' areas of consensus (Baskin, 2006).

Petrochemical safety is a pertinent issue; given that it helps protect lives of people as well as preventing the damage of property. Consumers, employees, shareholders, legislators and the communities for which the industry operates are all becoming increasingly aware of health, safety and environmental issues and demand ever-higher standards. Public trust and public belief in corporate responsiveness stem from the ability of organizations to uphold transparency in health and safety compliance issues.

“Productivity and Profitability go hand-in-hand with Health and Safety” (Meswani, 2008). Members of an OHS management system are key players in matters of occupational health and safety in the petrochemical sector. This traverses aspects of information, training, awareness, policy formulation, and generation of solutions among other things. To enable efficient execution of their roles, there is a need for effective levels of interaction between the OHS team and other players in the industry. Failure to acknowledge their significance in this industry could have a negative ripple effect, given that “though the impact of safety is felt immediately, the effects of OH related diseases are felt over generations” (Meswani, 2008). There are several opportunities for future research. Content analysis can be suitable for longitudinal research so that we can understand the trends in corporate social and environmental responsibility better. This research provides a cross-organization comparison of CSR reporting at a point in time. Therefore, an analysis of whether the social and environmental policies of the organizations change over time would be useful. There is an opportunity to perform an in-depth longitudinal assessment of CSR reports. A few proactive organizations have been publicly reporting on CSR since the late 1980s and early 1990s. Another opportunity is utilizing the CSR reports, is to compare these environmental reports with other publicly posted information such as the annual reports of other organizations in various industries. Most organizations are now required to report on certain aspects of corporate social and environmental sustainability. OHS professionals working with process, chemical, instrumentation, and metallurgical engineers, assure that potential physical, mechanical, chemical, and health hazards are recognized, and provisions are made for safe operating practices and appropriate protective measures. These measures may include hard hats, safety glasses

and goggles, safety shoes, hearing protection, respiratory protection, and protective clothing such as fire-resistant clothing where required. In addition, procedures should be established to assure compliance with applicable regulations and standards such as hazard communications, confined space entry, and process safety management" (Eyayo, 2014). According to the ILO and WHO, health and safety at work are fundamental rights and vital elements of the 'decent work' agenda. Occupational safety and health are an essential component of CSR and companies must recognize that they cannot be good externally while having a poor social performance internally (ILO, 2009). CSR- Corporate Social Responsibility (CSR) has been defined as the voluntary integration of social and environmental concerns into the firm's decision-making. The search for a good Occupational Health and Safety (OHS) environment and the promotion of a culture of risk prevention are two of the firm's main social responsibilities, and consequently an integral part of CSR. According to the ILO and WHO, health and safety at work are fundamental rights, and vital elements of the 'decent work' agenda. Occupational safety and health are an essential component of CSR and companies must recognize that they cannot be good externally while having a poor social performance internally. The CSR is more concerned with what organizations can/should go on to achieve beyond legal requirements especially in keeping workers safe. Companies are increasingly encouraged to use enterprise responsibility as a strategic investment into the core business strategy where OSH is concerned (HSE, 2005). In this way, OSH is treated as an investment, like quality management, where the result is sustainable. Transparency for organizations is a social responsibility that is required legal regulations to ensure operations directly linked to their business do not cause harm to the employees, and the environment.

Finally, this research contributed not only to the study of OHS reporting, but also in the content analysis of reporting from the oil and gas industry. These reports not only exhibit the company's social or corporate responsibility regarding health and safety alone, but also environmental and business effects that reflect the industry's processes. The Global reporting initiative, served as useful tool in comparing the 50 oil and gas companies, reporting as required by the standard.

REFERENCES

ACSNI Human Factors Study Group. (1993). Third report: organising for safety, advisorycommittee on the safety of nuclear installations. Health and Safety Commission HMSO, London.

Almanssoor. A. A. (2008). Planning of Petrochemical Industry Under Environmental Risk and Safety Consideations. Canada: University of Waterloo.

Al-Sharrah, G., & Elkamel, A. (2000). Strategic Planning of the Petrochemical Industry.

Baskin, J. (2006). Corporate Responsibility in Emerging Markets. Journal of Corporate Citizenship, 24, 29-47.

Baram, M., & Schoebel, M. (2007). Safety culture and behavioral change at the workplace. *SafetySci,* 45: 631-636.

Borman, W., & Motowidlo, S. (1997). Task performance and contextual performance: the meaning for personnel selection research. *Hum Perform,* 10: 99-109.

Boslaugh, S. (2007). Secondary Data Sources for Public Health: A Practical Guide. Cambridge University Press.

Boughaba, A., Hassane, C., & Roukia, O. (2014). Safety Culture Assessment in Petrochemical Industry: A Comparative Study of Two Algerian Plants. Safety and Health at Work, 5, (60-65).

Brown, J. (2014). Processing Petrochemical Safety. *Health and Safety Middle East.* Retrieved from: https://www.hsmemagazine.com/article/processing-petrochemical-safety-1117.

Carroll, J. S. (1998). Safety culture as an ongoing process: culture surveys as opportunities for enquiry and change. *Work Stress,* 12: 272-284.

Cooper, M., & Philips, R. (2004). Exploratory analysis of the safety climate and safety behavior relationship. *J Safety Res,* 35: 497-512

Cooper, M.D. (2000). Towards a model of safety culture. *Safety Sci,* 36: 111-136.

Cooper, M. D. (1998). Improving safety culture: a practical guide. Wiley J, Chichester UK.

Colbert, J. J. (2006, January 1). The Functional Role of Occupational Health and Safety in Corporate Sustainability: An Analysis of Possibility. American Society of Safety Engineers.

Cox, S., & Cox, T. (1991). The structure of employee attitudes to safety: A European Example *Work Stress*, 5, 93-104.

Cox, S., & Flin, R. (1998). Safety culture: philosopher's stone or man of straw? *Work Stress*, 12, 189-201.

Dedobbeleer, N., & Beland, F. (1991). A safety climate measure for construction sites. *J Safety Res,* 22: 97-103.

DeMaria, J. (2017, April 12). Organizational Safety Culture. Retrieved April 8, 2019, from https://ishm.org/organizational-safety-culture/

Duncan, S. (2012, January 16). Humans are social beings. So if you're not social, what are you? Retrieved April 8, 2019, from

http://www.stuartduncan.name/autism/humans-are-social-beings-so-if-youre-not-social-what-are-you/

Fan, Z. H. A. N. G. (2014). Development and safety research on Methanol-to-Olefins Process. Applied Mechanics & Materials, (614).

Fernández-Muñiz, B., Montes-Peón, J.M., Vázquez-Ordás, C.J. (2007). Safety culture: analysis of the causal relationships between its key dimensions. *J Safety Res,* 38: 627-641

Fuller, C., & Vassie, L. (2005). Benchmarking Employee Supervisory Processes in the Chemical Industry. Leicester: Lucent Ltd.

Guldenmund, F.W. (2000). The nature of safety culture: a review of theory and research. *Safety Sci,* 34: 215-257.

Griffin, M., & Neal, M. (2000). Perceptions of safety at work: a framework for linking safety climate to safety performance, safety performance, knowledge, and motivation. *J Occup Health Psychol,* 5: 347-358.

Hagan, P., Montgomery, J., O'Reilly, J. (2001). Accident prevention manual for business and industry (12th ed.), National Safety Council, Illinois, USA, Chicago (IL).

Hofmann, D., & Stetzer, A. (1996). A cross-level investigation of factors influencing unsafe behaviors and accidents personnel. *Psychology,* 49: 307-339.

Hong, Y.-J., Lin, Y.-H., Pai, H.-H., Lai, Y.-C., & Lee, I.-N. (2004). Developing A Safety and Health Training Model fo Petrochemical Workers. Kaohsiung J Med Sci, 20 (56-62).

Huaxing, Z., & Jingzhou, L. (2000). The Design and Trial Operation of the Residuum HydroTreating Process", Petroleum Refinery Engineering.

International Atomic Energy Agency (IAEA). (2007). Summary report on the Post Accident review meeting on the Chernobyl Accident, Safety Ser.

Junwei, L., Wei, Q., Yajuan, L., & Qian, L. (2014). Technology safety of using recycled water in Industries and landscape greening. China Water Resources, 17, (015).

Khan, F., Husain, T., & Abbasi, S. (2002). Design and Evaluation of Safety Measures Using a Newly Proposed Methodology-SCAP.

Leblanc, N., Berner, W., & Ogilvie, P. (2014). Conduit seals in hazardous locations-An ongoing safety issue the past and the future. In Petroleum and Chemical Industry Technical Conference (PCIC), 2014 IEEE (465-471). IEEE.

Lefranc, G., Guarnieri, F., Rallo, J.M., Garbolino, E., & Textoris, R. (2012). Does the management of regulatory compliance and occupational risk have an impact on safety culture? PSAM11 & ESREL, Helsinki, Finland.

Li, D. (2016). Perspective for smart factory in petrochemical industry. Computers & Chemical Engineering, 91 (136-148).

Maron, J.A., & Pena, J. S. (2006). The Process‟ Index: A New Methodology for The Evaluation of Operational Safety in the Chemical Industry.

Mulla, M. (2007). Effects of ISO Certification on the Safety Performance Level of Petrochemical Industries in Arabian Gulf Countries. University of Leicester.

Nagata, T., Nakata, A., Mori, K., Maruyama, T., Kawashita, F., & Nagata, M. (2017). Occupational safety and health aspects of corporate social

responsibility reporting in Japan from 2004 to 2012. *BMC public health*, *17*(1), 381. doi:10.1186/s12889-017-4356-y.

Neal, A., Griffin, M., Hart, P. (2000). The impact of organizational climate on safety climate and individual behavior. *Safety Sci,* 34: 99-109.

Neal, A., Griffin, M., Hart, P. (2006). A study of the lagged relationships among safety climate, safety motivation, safety behavior, and accidents at the individual and group levels. *J Appl Psychol*, 91: 946-953.

Occupational safety and health management and corporate social responsibility (CSR). (2013, April 24). *OSHWiki,* . Retrieved 17:08, February 19, 2019 from https://oshwiki.eu/index.php?title=Occupational_safety_and_health_management_and_corporate_social_responsibility_(CSR)&oldid=237897.

Pidgeon, N. (1991). Safety culture and risk management in organizations. *J Cross-Cultural Psychol*, 22, 129-140

Review Meeting on the Chernobyl Accident. (IAEA Safety Series Report INSAG-1).

Russell, S. (2019, February 11). Petrochemical Safety Topics. Retrieved April 8, 2019, from https://bizfluent.com/list-6612276-petrochemical-safety-topics.html

Siu, O., Phillips, D., & Leung, T. (2004). Safety climate and safety performance among construction workers in Hong Kong: the role of psychological strains as mediators. *Accid Anal Prev,* 36; 359-366.

Thaden, T.L., Wiegmann, D.A., Mitchell, A.A., Sharma, G., & Zhang, H. (2003). Safety culture in a regional airline: results from a commercial aviation safety

survey Proceedings of the 12th International Symposium on Aviation Psychology, OH, Dayton, Ohio, USA.

Veglia, A., Pahwa, M., & Demers, P. A. (2016). Establishing a Policy Framework for the Primary Prevention of Occupational Cancer: A Proposal Based on a Prospective Health Policy Analysis. Safety and Health at Work, 8 (29-35).

Vinodkumar, N., & Bhasi, M. (2010). Safety management practices and safety behaviour: assessing the mediating role of safety knowledge and motivation, 2010 mediating role of safety knowledge and motivation. *Accid Anal Prev,* 42: 2082-2093.

Wang, F., Gao, J., & Guo, K. (2009). A Hazard and Operability Analysis Method for The

Prevention of Misoperations in the Production of Light Mag Carbonate, *Journal of Loss Prevention in the Process Industries*, 22: 237-243.

Wang, F., Chen, Y., Wang, H., Chen, C., Shi, B. (2012). The Intrinsic Safety Engineering Design Method for The Petrochemical Plant.

Wilpert, P. (2001). The relevance of safety culture for nuclear power operations in B. Wilpert, N. Itoigawa (Eds.), Safety Culture in Nuclear Power Plant, Taylor & Francis, London, 5-18.

World Health Organization. (2014). Health-sector Involvement in Chemicals Management at the National Level: Review of Current Practice. Copenhagen: World Health Organization.

Yankauer, A., & Rothman, K. (1984). The Environment Returns to the Health Department. *American Journal of Public Health,* 74 (1,2).

Zohar, D. (1980). Safety climate in industrial organizations: theoretical and applied implications. *J Appl Psychol,* 65: 96-102.

Zohar, D. (2000). A group-level model of safety climate: testing the effect of group climate on micro accidents in manufacturing jobs. *J Appl Psychol,* 85: 587-596.