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Lack of dynamic leadership skills and human failure contribution analysis to manage risk in deep water horizon oil platform

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ABSTRACT

This paper analyses the case study of Macondo Well Blowout and the failures of dynamic leadership skills and human contribution to process risk. The Deepwater horizon oil platform in the Gulf of Mexico was owned by Transocean and operated by British Petroleum (BP), this disaster took place on April 20, 2010 in off the coast of the Gulf of Mexico that eventually led to an oil spillage. Millions of barrels of oil flooding into the sea and beaching the shore. The analysis was executed by identifying the human factors, hazardous conditions, developing FTA, and constructing a pairwise matrix. The analytic hierarchy process (AHP) was performed to evaluate the Consistency Index (CI), Quality Index (QI), and the overall qualification of influencing factors. From the results it was observed that the least QI value was found in the factor failure to gain control of well response and the factor negative pressure test has 36% which recorded as the highest QI. On the whole, the overall qualification of influencing factors is marked as poor. Ultimately, these results demonstrate that this tragedy is due to complete human errors and it is the evidence of both Transocean and BP employee's poor leadership abilities.

1. Introduction

On April 20, 2010 the Deepwater Horizon (DWH) oil drilling platform exploded and released over the adjacent 3 months a government estimated 4.9 million barrels of oil, becoming the largest marine oil spill in the United States History (Judy et al., 2014). During the Deepwater Horizon oil spill in the Gulf of Mexico between April 20 and July 15, 2010, over 800 million liters of crude oil were gushing from the Macondo well to the water column, exerting greater adverse effects on the marine life, human health, and natural resources in the northern Gulf of Mexico (Zhou et al., 2013). The absolute mass of oil caused widespread impacts, including the oiling of approximately 796 km of Gulf Coast marshes; this included approximately 304 km of Louisiana marshes classified as moderately to be heavily oiled (Michel et al., 2013). The British Petroleum (BP) supermajor oil and gas company who was accused and took the full responsibility for this catastrophic event, BP is a British multinational oil and gas company having operations all over the globe, this Deepwater horizon rig was owned by Transocean and operated by BP. The BP oil rig team made incorrect evaluations of the drilling operations, BP contracted Halliburton an energy service company for carrying out the cementing operations in the Macondo well. The engineers at the platform wrongly made several engineering judgement and failed to perform the maintenance operations that in the end led to a devastating historical scenario. Over, 40 years the Shell-USA oil company had successfully drilled 35,000 wells in the Gulf of Mexico, they lambast and blame BP by commenting that, this unexpected incident is an act of pure human errors and poor leadership qualities (Hofmeister, 2013). In 2007, Tony Hayward replaced Mr. John Browne as CEO of BP PLC and upon swearing in ceremony, he said that, he would act as a laser in health and safety policy of this company. During the incident on 2010, he was severely criticized for his statement by the US Department of Justice. The failure of oil rig process risk analysis by identifying the human and organizational components will lead to disastrous consequences, such as the collapse of offshore structures and that in turn leads to multiple fatalities and extensive damage to property, production, and the environment (Norazahar et al., 2014).

Thus, this paper presents a framework for analyzing the Macondo well blowout issues based on human and organizational factors. The outcome of this model can be used to identify and implicate the best factor of this DWH explosion in the Gulf.

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Also, good qualities for effective leadership was suggested in this paper.

1.1. Problem background

The Macondo Blowout chronology incident as follows, on April 20th the well integrity test was carried out, the negative pressure test was falsely interpreted to be successful, while carrying out the negative pressure test the BP team leader noticed that the crew are using a procedure that is not BP preferred method the operations are reconfigured to meet the requirement of the permit. The sea water was pumped into the kill line to confirm whether if it is full and this was monitored for 30 min which shows no flow. The crew started the activities for temporary abandonment of the well, but the well into an underbalanced position causing hydrocarbons to flow. The drill pipe pressure increases, but this was not noticed. The mud overflows onto the rig floor, the crew diverted the mud flow to the mud gas separator but the drill pipe pressure steadily increases. Mud and hydrocarbons discharge onto the rig and overboard. The gas alarms sound, gas entered the engine room and there was an explosion. The cables which will allow the emergency shutdown system to communicate with the BOP was damaged. The emergency shutdown was not successful and the BOP was unable to seal the well. This disaster led to the death of 11 workers and destruction to the environment and property.

While the impact due to oil spill was considered to be severe, British Petroleum (BP) made several attempts initially to cap the well, but their efforts failed. At last, on July 15, 2010 the Macondo well was capped to prevent any leak, finally on September 17, 2010 the well was permanently sealed (McAndrews, 2011). It has been estimated that 70% of the offshore blowout accidents happen due to human failures and the remaining 30% is attributed by technical failures (Cai et al., 2013). Specifically, in Macondo well blowout, there were a series of technical mistakes, wrong engineering judgements, improper maintenance and communication, lack of leadership, structure and component failures that wholeheartedly contributed to the tragedy.

2. Analysis from the angle of drilling operation

The blowout of Macondo well has unleashed serious fears on the offshore drilling safety. The Deepwater horizon drilling rig was thought to be safe and productive drilling unit since for past seven years from the incident, there were no personal injuries and technical damage, said by BP officials (Skogdalen et al., 2011). But on the 20th April 2010 night approximately 9.45 pm local time, gas exploded up the wellbore onto the oil platform deck and caught fire. Consequently, 11 crew members killed in the explosion of the rig. High pressures, high temperatures, complicated casing process, uncertain seismic, difficult formations, lack of skilled and experienced professionals, and high cost are such challenges involved in the deepwater drilling (Addison et al., 2010). Also, the well integrity plan was not properly established by the drilling crew in the rig. Well integrity is the combination of operational, technical, and organizational expertise to reduce the risk of uncontrolled flow of hydrocarbons from formation throughout the life cycle of the well (Norwegian Oil Industry Association, 2004). This eventually led to the release of kick, it's an unusual occurrence in which the phenomenon of hydrocarbon influx due to differences in the formation and hydrostatic pressure.

This is the major hazard associated with drilling operations and one the main reason behind the rig explosion. Generally, the mud engineer should prevent the kick formation in the way that the mud (drilling fluid) pressure is higher the formation pressure as this process is safe, but it is uneconomical due to formation damage and tedious work (Abimbola et al., 2014). Nowadays, in most of the offshore drilling, especially in the North Sea a different drilling technique is employed is called managed pressure drilling (MPD). It is an adaptive drilling process used for accurate control of the annular pressure profile throughout the wellbore (Frink, 2006). MPD offers a system of closed-loop circulation in which the bottom hole, pore, and formation fracture pressures are balanced and managed at the surface. Drilling fluid is added by surface backpressure, which can be adjusted soon in response to the conditions of the downhole compared with the conventional changes in mud weights (Schlumberger, 2016). Fig. 1 presents the general hydrocarbon well profile.

Rig crew has executed an improper cementing job and this being a second main reason for the blowout. The day before the tragedy, the cement had been pumped down the production casing and to wellbore surface for preventing the formation fluid entry into the wellbore. The annulus cement that was positioned across the main zone of hydrocarbon was a nitrified foam slurry of cement, which is light. This cement annulus probably undergone nitrogen breakout and migration, consequently allowing formation fluids to come in the annulus of wellbore. The accident investigation team concluded that there were weakness in the design and testing of cement, risk assessment and quality assurance (Executive Summary, 2010). Fig. 2 shows a typical cementing procedure for an oil and gas well.

The critical nature of cementing process is during the casing and cementing operation, liners are placed for lost circulation isolation. In practice, it is very difficult to get a good cementing job on a liner due to the less annular clearance between the liner and open hole section. Thereby, experiencing a difficulty in running and the cement slurry has been frequently susceptible to contamination by the drilling fluid (mud) and there is a frequent difficulty in succeeding engineering tolerance in linear movement for good placement of cement (Abimbola et al., 2016). Hence, it is evident that fossil fuel exploration activity in offshore environment is recognized by risk of kick during drilling and well control operations. Efficient measures must be taken when the kick is detected and if it ignored or failed to control this problem, a severe well blowout will occur, leading to a loss in machineries and lives (Feng et al., 2016). Therefore, this section describes on why human factors are critical in drilling operations and thus, there is the need for investigation of human and organizational factors associated with Macondo well blowout.

3. Process Hazard Analysis (PHA)

Generally, Process Hazard Analysis (PHA) is an organized attempt to identify and assess risks associated with chemical processes and operations to enable their control. This review normally involves the role of qualitative techniques to find out and evaluate the significance of hazards. The purpose of using PHA is to understand how it can be used as a technique to prevent accidents and to learn about debating the importance of determining the worst case scenarios. According to Kariuki and Löwe (2007) a typical PHA comprises of the following chart.

Fig. 3 shows the potential hazards chart associated with an offshore oil rig, these hazards were compiled by Christou and Konstantinidou (2012). In the first procedure, it indicates the identification of potential hazards that is the possible hazards involving around the oil rig should be identified. The second measure is to establish an engineering evaluation or administrative controls subjected to the process hazards. The last step is to evaluate and demonstrate the consequences of failure of the controls by using appropriate PHA methods like a hazard and operability study (HAZOP), fault tree analysis (FTA), Failure mode and effects analysis (FMEA), etc.