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Performance Evaulation of TRACER-OGI in Analyses of Reported Accidents in Oil and Gas Industry from the Archive of Health and Safety Executive of United Kingdom(UK)

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Abstract: *Oil and gas are among the most vital resources in the world today for economic development, however, its transformational processes are very expensive intends of investment and very risky and prone to catastrophic disasters through accidents. Oil and gas activities in nature, generate negative consequences effect on the ecology and the environment from exploration to decommissioning stage. The most fundamental cause of accident in oil and gas industry and its processing is identified to be human error. Human error is therefore classified as common factor that leads to the damage of environment as well as loss of lives. TRACEr-Oil and Gas industry (OGI) was adaped to Analyse 45 reported Accident published by UK Health and Safety from 1996 -2005. However, the raw data was coded according to the content of TRACEr-OGI. A total number of 45 different errors under the major division of TRACEr-OGI were collected, identify and analyze using percentage, and bar chart diagram. The result revealed that all the accident are in the offshore facilities with major casualities from the operators and other technical personnels. Task Error contribute (64.4%) which affect personnels in the cause of their duty. Persformance shaping revealed (86.7%) which is the most highest errors that contributed to accident within these years after external error mode. Equipment Error constituted (84.4%) of errors that led to acccidents both from operators and technical personnels which are mostly due to lapses in performing their task. However, cognitive domain cause (68.9%) of the errors and this might be due to inadequate supervision and poor communications from operators to technical personnels on site in addition to poor decision making by technical personnels. Mechanical failure falls under equipment error have also contributed (80%) errors that led to accidents in the offshore platform. Similarly, error mode which is in different stages such as; state of confusing, fatigue, and distraction has however contributed about (68.9%) of such error that further led to major accidents within these years.*

Key words: *Accident, Health, Safety & Tracer OGI*

Introduction

Oil and gas are among the most vital resources in the world today for economic development, however, its transformational processes are very expensive intends of investment and very risky and very prone to catastrophic disasters through accidents. Oil and gas activities in nature, generate negative consequences effect on the ecology and the environment from the exploration to decommissioning stage (Alazzani & Wan-hussin 2013). According to Deacon et al., (2013) study, the most fundamental cause of accident in any industry either in oil and gas or its processing is identified to be human error. Human error is therefore classified as common factor that leads to the damage of environment as well as loss of lives (Alkhldi et al., 2017). The most sophistical and catastrophic ever known disaster in the oil and gas industry was piper alpha explosion that claimed the lives of 167 people and was due to human error which further influence the establishment of safety and regulation act of 1992 through the health and safe executive in the UK from the recommendation of lord Cullen's (Crawley, 1999). However the regulation Acts of the 1992 has now been amended to SCR 2005. Similarly, the incident of Sea Chem sinking into the sea due to mechanical failure at the North Sea in 1965 has also claimed the lives of 13 people and subsequently led to the passing of legislation on mineral Acts installation on offshore of 1971. These Acts produces details frame work for safety on the offshore and is similarly connected to the outer continental shelf Land Acts of 1953 that of US (lindoe et al., 2012). Furthermore, the Alexander, L. Kielland accident on offshore in 1980 has about of 123 fatalities (Almar-Naess et al., 2009). These accidents has further buttress the establishment of regulation Acts associated to the safe practice Acts of 1975, and 1976 respectively. Conversely this Acts work with the environment Act of 1977 which is also related to the UK workers mineral Act of 1971(lindoe et al., 2012). Similarly, the Sea crest accident in 1989 has also claimed the lives of 91 crews on board (Mannion, 2013). Likewise in Newfoundland Ocean Ranger disaster in 1982 has also recorded about 84 fatalities due to human error and eventually equipment failure (Price, 2013). Additionally, the BP Macedon well blowout in 2010 killed about 13 workers on site and resulted in one of the top largest offshore oil spilt in the history. Afterward of the accident resulted in the enactment of offshore installation Safety Case of 2015 which is also connected to the Norwegian revised regulation Acts of 2011(lindoe et al., 2012). These Acts is in line with the US regulation Acts of SEAMS 2010, and BOEMRE 2011Acts respectively. UK legislation on safety case Acts has provided a continual improvement in the processing industries globally (Arewa & Farnell, 2012). After these safety regulations Acts, majority of the accidents on offshore platform in oil and gas industries which are connected to human error have reduced (Vinnew, 2013). Nowadays, most of the industries are now focusing on human reliability assessment (HRA). Human error assessment and Reduction technique ''HEART'' is a tool that is generic which is universal to any sector that human reliability is paramount important, some of this sectors are Aviation, medical and nuclear sectors (William, 1988). Additionally ''CREMA'' which is an Error Analysis technique was established and applies to nuclear industries, similarly, it can also be apply to rail crash accidents evaluation (Hollnagel 1998: 20; Marseguerra et al., 2007).

Technique for human rate prediction ''THERP'' can be used in many different industries but was actually designed for nuclear industry (Swain & Guttman, 1983). THERP is among the first generation tool for reliability assessment (HRA) which followed that of the conventional reliability analysis model for machines (Hollnagel, 2005). Human factor investigation tool ''HFIT'' is a generic tool use in the Analysis of Human factor related Accidents (Gordon et al., 2005). The ''HFACS'' was design for Aviation industry to evaluate human performance in relation to the use of machines but later modify to human factor analysis and in the classification of oil and gas industry system ''HFACS-OGI'' (Theophilus et al., 2017). Furthermore, the Emergency Human Error Analysis technique ''EHEA'' is use for the analysis of Human error in the processing industries during an emergency circumstances for performance evaluation (Petillo et al., 2017). TRACEr is a tools use for identification of Human error retrospective and predictive (Thoephilus et al., 2017).

AIM

Is to use TRACEr-OGI to analyze oil and gas related accident in UK to determine the fact about the accidents.

OBJECTIVES

- To review TRACEr-OGI and applied it to Oil and Gas industry accidents
- To investigate and analyze oil and gas reported accidents that has fatalities over a period of 10 years in United Kingdom

LITERATURE REVIEW

Inspired the development of numerous human identification error techniques, most of this tools were only utilized in the industries. However, in the development of Hazard identifications tools, reliabilities and assessment were basically for technical use but relatively neglect Human factors (Shorrock & Kirwan, 2002). But study by Stanton and Buber, (2002) further criticized that, though most of these HEI techniques are very useful but are predictive and narrowed to specific domains. For instance ‘‘HAZOP’’ technique was limited to accident prediction and it does not cover monitoring of potential risk as well as operational problems (Koscielny et al., 2017). According to Johnson, (1999) study which suggested that human factor focuses widely on the accident than occurrence for this reason reliability of human has less impact in the industries. Similarly in ‘‘THERP’’ the Reliability for human performance were not cover in the taxonomy in addition to system failure, and assessments were also limited to some specific areas (Shirley et al., 2015). According to Cacciabue, (2000) study revealed that performance evaluation for reliability in human always observes through errors. Therefore these techniques have created barriers in the development of TRACEr oil and gas (TRACEr –OGI).

HEALTH AND SAFETY MANAGEMENT TOOLS

In the early 1980 there are minimal legislation and regulation in the processing industries thereby leading to the damage of facilities in the production platform such as Piper Alpha disaster cause by poor maintenance. The new legislations and regulation Acts as improved safety in the oil and gas industries (Theophilus et al., 2017). British Standard (OHSAS 18001) is a global framework for the standardization in the management of occupational health and safety. It is a tool use to eliminate potential risk and potential operational hazard in the industry (Badri et al., 2018). Furthermore ISO: 45001 has also provided a global framework for combating risk and potential hazards thereby creating safe and enabling environment for the oil and gas industries. The six fundamental elements for safety management system are; safety plan, policy, induction, monitoring, supervision and reporting. Therefore, proper adherence of those elements in any industries might produce safe working environment (Weekes, 2017). Many organizations and institution irrespective of their size adapt (BS 18001:2007) as part of management strategy in promoting health and safety for their workers, it also promotes legislations changes (Degan et al., 2009). According Hamita et al., (2020), Planning is to identifying the potential risk, and hazard involves in preparation for an emergency response taking into consideration the standards in order to achieve the desire objective. However, the implementation of OSHSAS is to carry out risk assessment audit, in addition to the routing inspection, as well as the evaluation of the risk and hazard through the auditing (Khairda et al., 2018)

TRACER REVIEW

The Human Error Identification tools ‘‘TRACEr’’ was initially developed in year 1999 in order to classify the causes of accidents associated with human error when there was an increase in the volume of Air traffic usage in the UK (Isaac et al., 2002). It is a methodology for the identification of human error developed to evaluate the reliability of human in the control of Air Traffics. This tool has greatly contributed positively in minimizing the errors that usually led to accident in the Air traffic control (ATC) industry in UK (Graziano et al., 2014). However, it has eight (8) taxonomies in the classification of errors and subsequently reveal where such an error occurs (Rantanen & Nunes, 2005). It was developed when many of tools in the Air traffic control (ATC) industry where inadequate in addressing assessment challenges. The major problems ranging from the lack of constant utilization of the tools, comprehensive structure or excessive resolution and the contextual validities to the ATC, its applications become restricted (Shorrock & Kirwan, 2002). According to Baysari et al., (2011) study, the technique for Retrospective and Predictive Analysis of Cognitive Error is very complex but suitable to Aviation. Therefore ‘‘TRACEr’’ is very unique and flexible tool that can be use and implement into the assessment of incidents associated with Task errors identifications and Cognitive predictive Errors (Thoephilus et al., 2017). Consequently it enable both retrospective and predictive evaluation of accidents, and it is widely focuses on the interface between human performance reliability assessment and machine taking into cognizance the external factors that affect their performances (Graziano et al., 2016). It is originated from varieties of reviewed literatures, events and activities that provided better understanding in the control of ATC errors in order to avoid accident (Shorrock & Kirwan, 2002). ‘‘TRACEr’’ can be use simply because, it provides room for error description, and their classification in details. In addition to the occurrence of the flaw from a designate places, the mechanism, psychological reason for error event, and the situation that give rise to the errors, to be all identify and retrieve in providing answers (Shirali & Malekzadeh, 2016).

TAXONOMY OF TRACER

‘‘TRACEr’’ technique is different from other human error identification tools for reliability assessments, because the tool is attempting to provides balance between the theories and the practice taking into consideration the interface between machine and human (Theophilus et al., 2017). There are two distinct models in the development of TRACEr, the model for human information processing and cognition model for error identification (Graziano et al., 2014). The first model was developed based on the human cognitive performance and how physical parameters does affect it investigations (Wickens, 2014). Figure 1.1 shows TRACEr and its taxonomies. According to Isaac et al., (2002), the model for processing will be a key in performance evaluation in the area of decision makings. However on the other hand, the second model emphasis on the interaction of cognitions from planning to execution of human reliability (Hollnagel & Cacciabue, 1999).

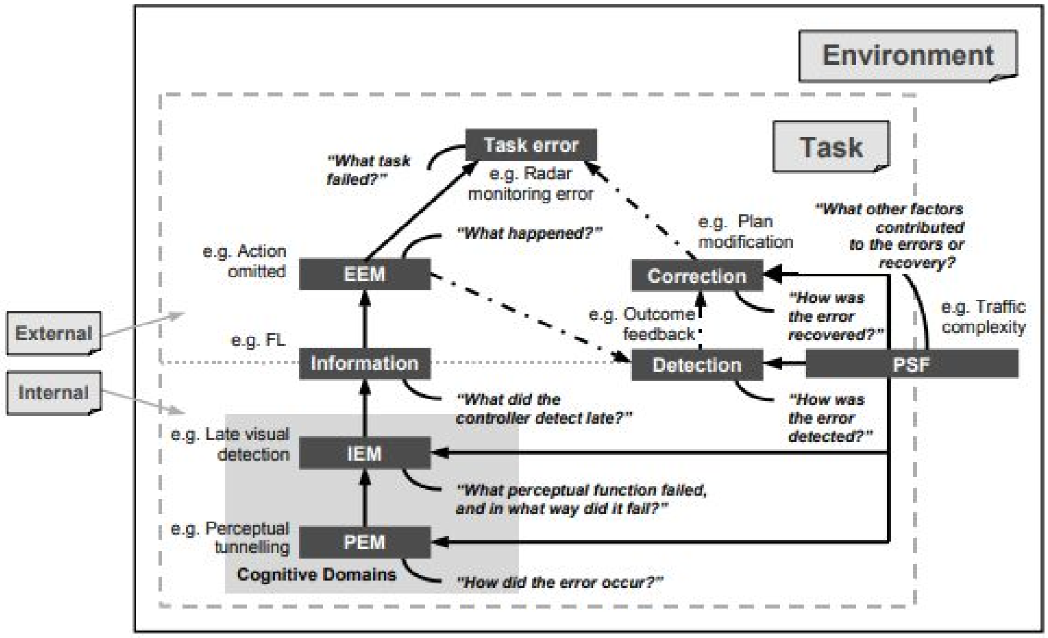

Figure 1.1 TRACEr Taxonomy Structure and Categories adapted from (Shorrock & Kirwan, 2002).

However, it was developed for the retrospective performance evaluation in the ATC industry (Schorrock & Kirwan, 2002). Rail industry has equally modifying TRACEr and tie into retrospective and the predictive assessment (Baysari et al., 2009). Furthermore due to the flexibility of TRACEr taxonomy, the tool can be adapted into oil and gas industry taking into cognizance some modifications into the taxonomy which includes sub-task shape into the oil and gas industries, table 1.2 shows TRACEr-OGI taxonomy with the new modifications. In the Oil and Gas industries, there are certain errors which the existing taxonomy for retrospective and predictive does not accommodate them because the tools were basically designed for human error identification. Similarly, experts are of the opinion to maintain the three (3) major classification of the TRACEr in any potential modifications process. Therefore, the subsequent modifications were formulated by Thoephilus et al., (2017) into the ‘‘TRACEr Taxonomy’’ to make it suitable for performance evaluation and reliability, retrospective, predictive, and cognitive assessment in the Oil and Gas Industry. The TRACEr-OGI has now Equipment Error under the context of incidents as category three (3), but in order to identify errors in mechanical system TRACEr only account for information and equipment error this is because it does not code the errors cause by mechanical appliances (Graziano et al., 2016). In Oil and Gas Industries there is a relationship between integrity, personnel and mechanical systems (Hassan & Khan, 2012). Table 1.0 shows the modified TRACEr into the Oil and Gas Industry and its taxonomies. However, causality levels were divided into minor, major and catastrophic in the TRACEr-OGI. Accident that has fatality with severe damage is classified under catastrophic in TRACEr-OGI. Similarly the major categories are injuries that are permanent, while does that requires first aid are considered to be the minor. Further modification on Recovery errors were reviewed into control Barrier and recovery measure with two sub-divisions into Hardware and Human Barrier, thus TRACEr-OGI become simply, flexible, reliable and easy to use as formulated by Theophilus et al., (2017).

MAJOR DIVISION	CATEGORIES
Context of the incident	1. Task Error 2. Error information 3. Causality Level
Operator Context	4. External Error Mode 5. Cognitive Domain i) Internal Error Mode ii) Psychological Error Mechanism. 6. Performance Shaping Factor
Error Recovery	7. Error Recovery.

Table 1.0 TRACEr Taxonomy adapted from (Thoephilus et al., 2017)

METHODOLOGY FOR ANALYSES

Oil and Gas accidents information's were obtained from the data page of IOGP which was published by UK health and safety executive. TRACEr-OGI taxonomies were used in identifying the accidents distinctly. However those incidents were from offshore platforms documented after thoroughly investigation by the experts and were deposited in the archive of the health and safety executives of the United Kingdom. Furthermore, the study considered a total of 45 incidents that were documented from 1996 to 2005 covering a period of 10 years in the offshore industry in order to used TRACEr-OGI (Oil and Gas industry) taxonomies to evaluate, analyze the context of the incident, and their categories. The raw data was coded according to the content and categories of the TRACEr-OGI. A total number of 45 different errors under the major division of TRACEr-OGI were collected, identify and analyze using percentage, and bar-chart.

ANALYSIS AND DISCUSSION

The bar-chart in figure 2.1 shows the number of accidents over the past of 10 years from the data base of UK health and safety executive. According to this trend the numbers of accidents increased to its peak in 1999 to about 22.2% which is highest recorded within these years. However, it was not the accidents that increased during this year but the new legislations particularly from the continental shelf of Norwegian which mandated all offshore accidents to be reported to the health and safety executive (Christou & Konstantinidou, 2012). Conversely according to the Health and Safety Executives, the reported numbers of accident in 1999 were as a result of increase in the workforce from initial personnel of 27,200 to 29,003 in that year which was due to the advancement in the exploration of multilateral and horizontal well exploration technology. This change is associated with the new regulation and enforcement in the design & construction of offshore regulation Acts of 1996 and 1998 respectively (Loughney et al., 2018). Hence the establishment of offshore safety regulation law has controlled and reduces all the major risk and hazards involved in the oil and gas industry (Flin, 1996).

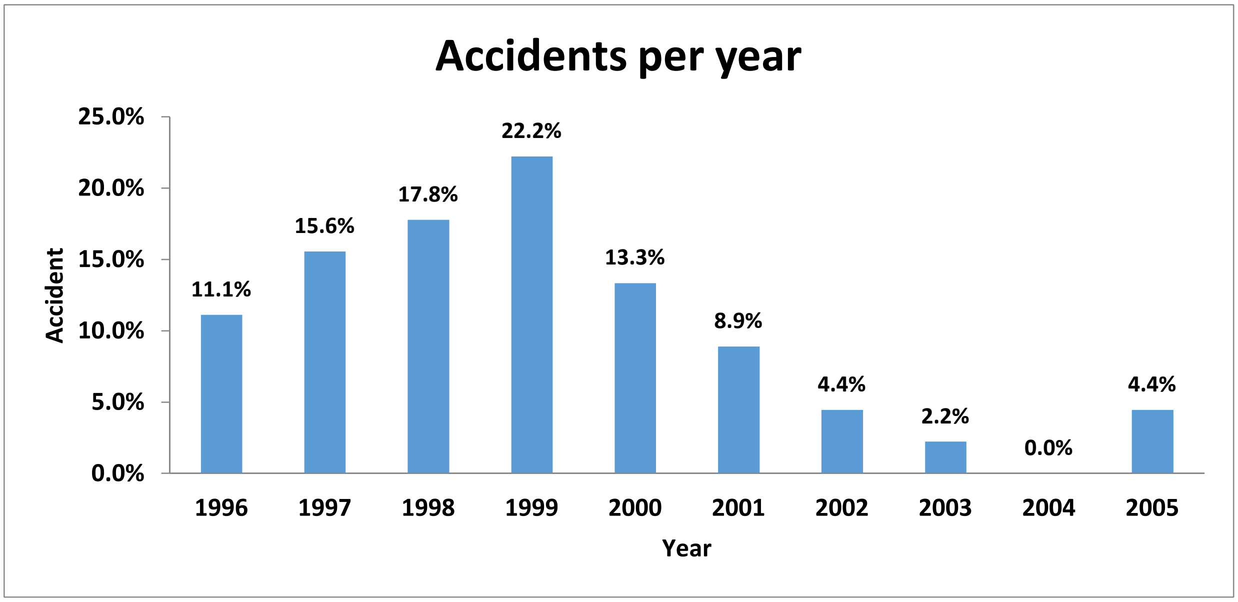

Figure 2.1 Accident per year

FATALITY PER YEAR

Additionally, according to the data based the fatality rate is still proportional to the number of accidents this is because, the year 1999 recorded the highest percentage rate and is the same year that recorded highest number of reported accident. However, most of those fatalities are as a result of minor incident that later metamorphosis to become fatalities during hospitalization or in some cases after discharged (Vinnem 2011). Similarly according to Vinnem (2014: 659) study, the globally rate of fatality has increase from 1997 to 1999, while the UK offshore has a average of 1.89 per million exposure hours which is consistence with chart in figure 2.1

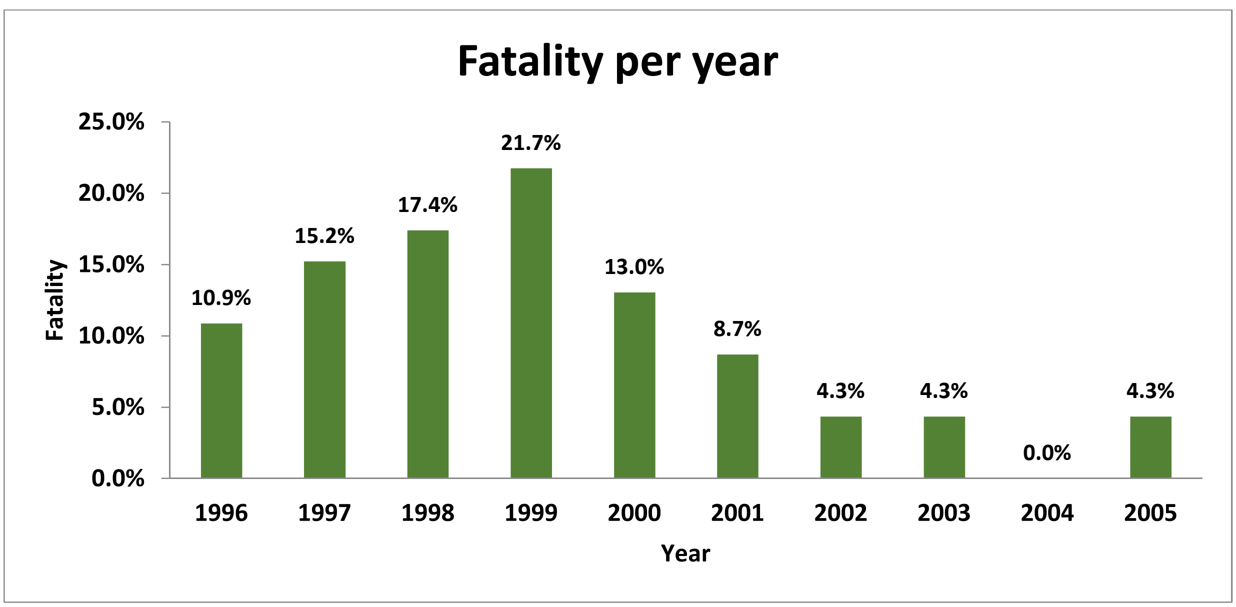

Figure 2.2 Fatality per year

Fatality per event, despite the continual improvement via the regulation and legislation Acts on offshore, the occupational accident within the last 10 years is still a major disaster, since 1999 along contributed more than 60%. This statistics has further reveals that most of these accidents are from occupational activities ranging from the falling from a height, slips and trips which accounted for about 53% from 1998 to 2002. These increases were as a result of compliance with laws and new legislations as government is attempting to effectuate successful implementation of policies by enforcing laws and regulations (Attwood 2006, Loughney et al., 2018).

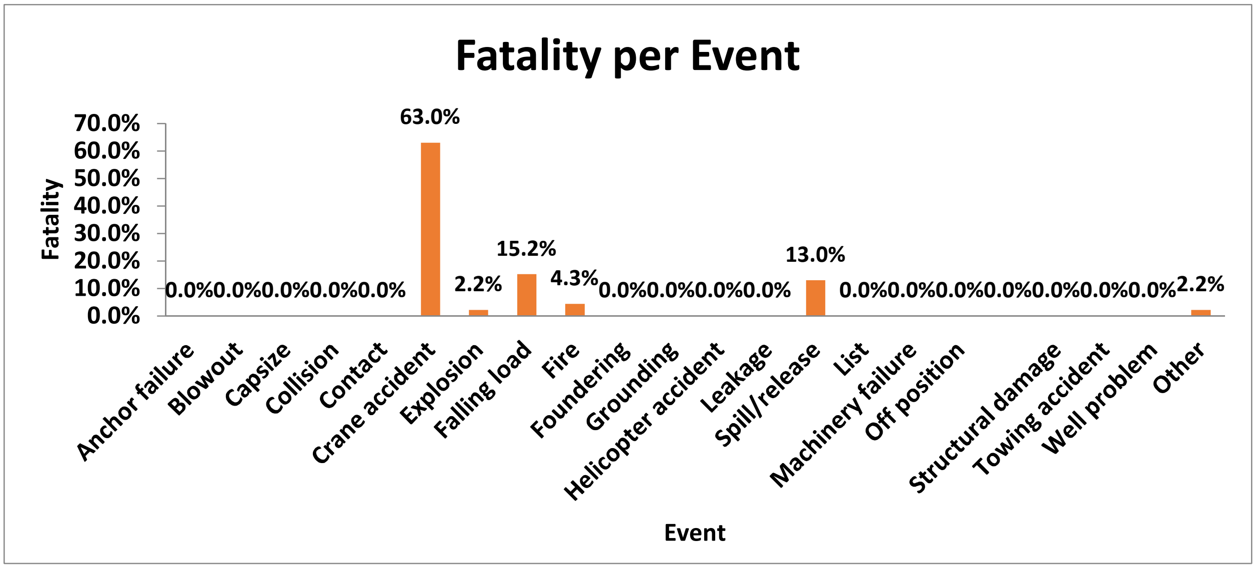

Figure 2.3 Fatalities per Event.

FATALITY PER PLATFORM

Production and drilling platforms are the most complex and risky task in oil and gas industry due to technical nature of the job. Likewise figure 2.3 revealed that within these 10 years, fatality under production platform and drilling stood as 71.1% which is higher than any other platform. However, failure from production and drilling might sometime result in oil spill thus extraordinary care is always required to handle such task with expertise.

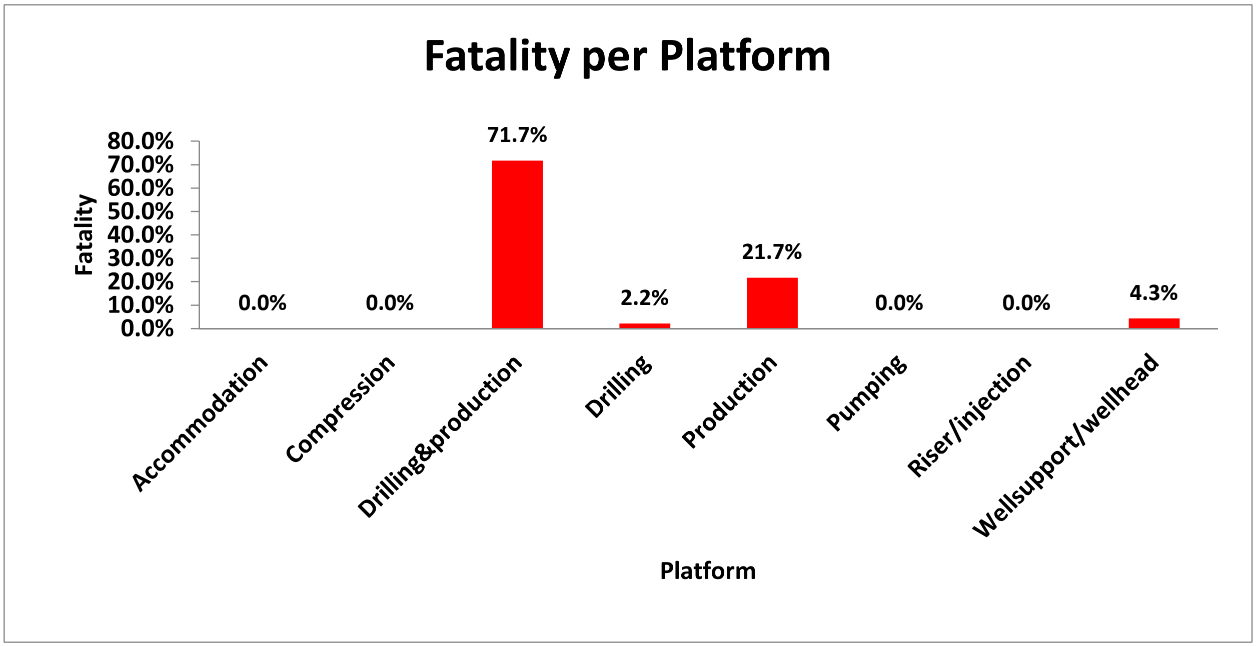

Figure 2.4 Fatality per platform

DISCUSSION FOR THE CONTEXT OF ACCIDENTS

The main TRACEr category where further divided into three (3) sub-headings which consist of Task Error which contributed 23.0 %, with Casualty of 35.7%. Additionally, Error information contributed 12.7%, with Equipment Error of 28.6%. Figure 2.5 represent the chart for Human Error against the accident categories under the context of incidents. However, Task Error also focuses on operators activities from Designers, to Electrical Engineers, as while as Drillers activities. Moreover it also includes other technical activities of operators that are poorly performed which lead to accidents. The Error information is a detail breach of communication in the process of conveying information that further lead to become Accident. Similarly an Equipment Error is a technical error when barriers fails and subsequently lead to accident in addition to other factors from both human and machines.

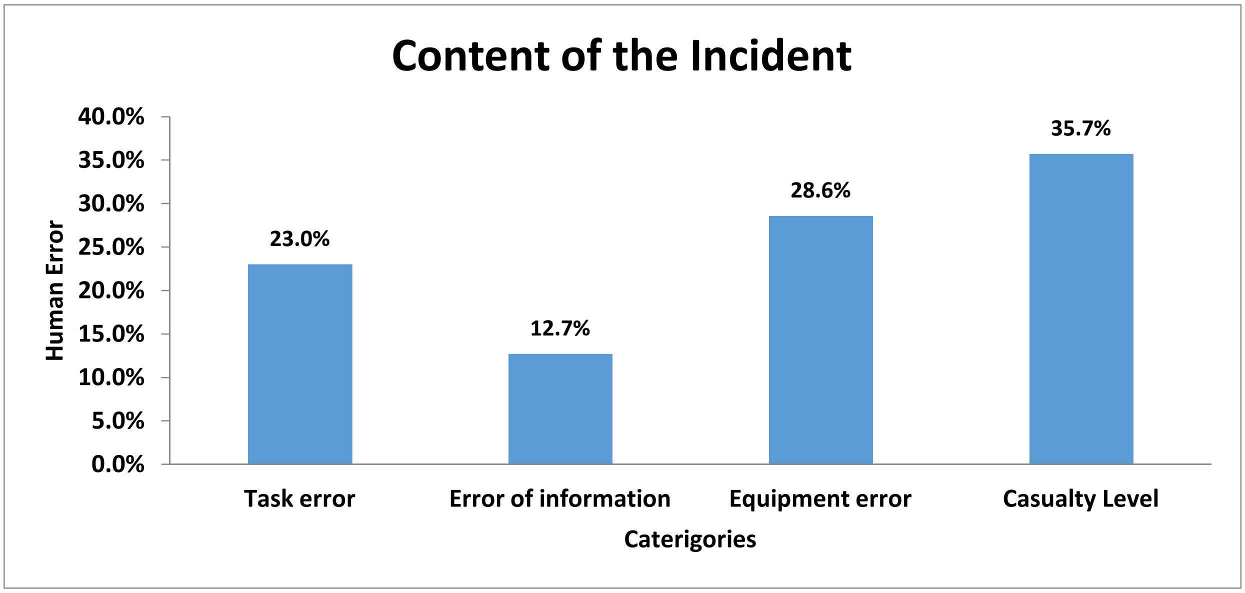

Figure 2.5 Context of the incident

OGI-TRACER CATEGORIES

The TRACEr-OGI categories for the 10 years period is represent in figure 2.3, with sub-divisions of; Task error which contributed 64.4%, Error information of 35.6 %, Equipment Error 80%, with Causality of 100% respectively. An External error Mode accounted for 84.4%, Cognitive domain 68 % and Performance Error 86.7%. Similarly, Hardware barrier add 53.3% of the errors with Human Barrier 24.4%. According to Theophilus et al., (2017) study reported that accidents are basically on the Unit of offshore taking into cognizance manned and the unmanned. Those units were from drilling, accommodation, injection/riser, production, compression, well support/wellhead and pumping. Task Error under the TRACEr-OGI categories make up 64.4% of the total accident within this 10 years period. The TRACEr-OGI categories recorded a casualty of 100%, this is because the entire accidents within these 10 years have mostly casualties recorded and subsequently led to these high fatalities rate. However the data base contains some secondary causality but this work is however limited to the primary causalities only.

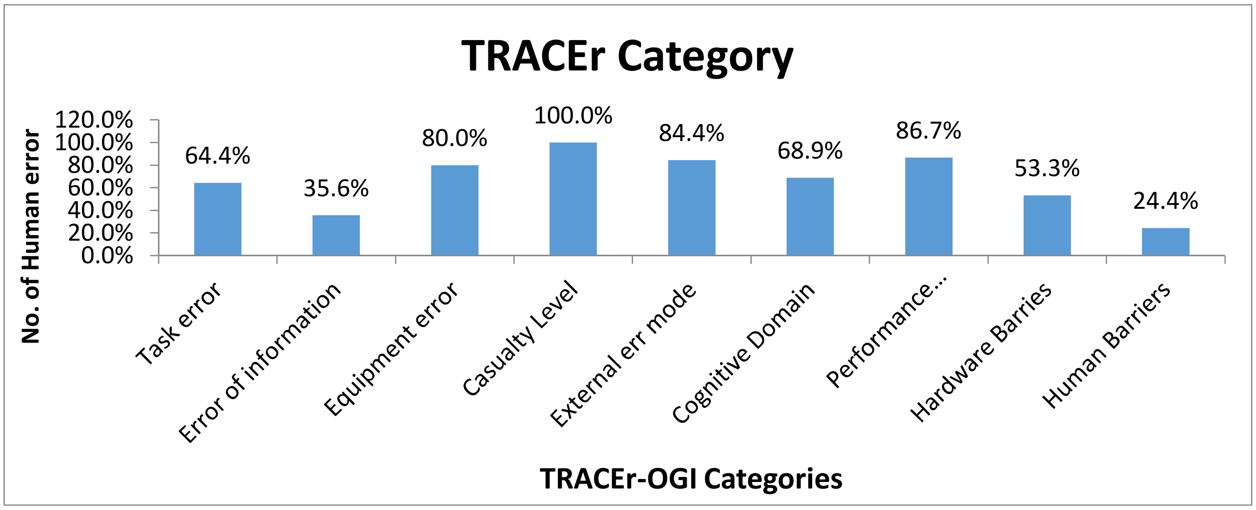

Figure 2.6 OGI-TRACEr Categories.

The results further revealed that Error information has added a 35.6% to the total accident under the OGI-TRACEr within the 10 years period. Thus, it is essential to identify those activities and equipment that led to an accident (Graziona et al., 2014). Similarly, from figure 2.6 and 2.7 the rate of crane fatality to event is 63% and drilling to production is 71.7% which are equipment error and failure which then further make up the 80% of the error for the entire 10 years period of the accidents recorded. Over the 10 years period a cognitive domain has influence an error on the reliability of safety, since the results revealed that perception and violation of standards, poor decision marking has influence many accident (Rundmo et al., 1998). Additionally under the psychological error mode which is in different stages; such as state of confusing, fatigue and distraction are major factor that led to 68.9% of the accidents. The final taxonomy of OGI-TRACEr comprise of Hardware barriers and Human barriers. The Hardware and Human barriers are use to monitor if there are threats in order to recognize and prevent accident occurrence. But in this analysis hardware barriers accounted to about 53.3% while human barrier add 24.4%, however if barriers prevent accident according to Theophilus et al., (2017) then incident become near miss. Unfarmilarity and workload are the major factors that increase rate of accident in oil and gas industries (Rundmo et al.,1998). Similarly in figure 2.7 which revealed that, hardware barrier account for 68.6% to the incident of human error with human barries 31.4 % error.

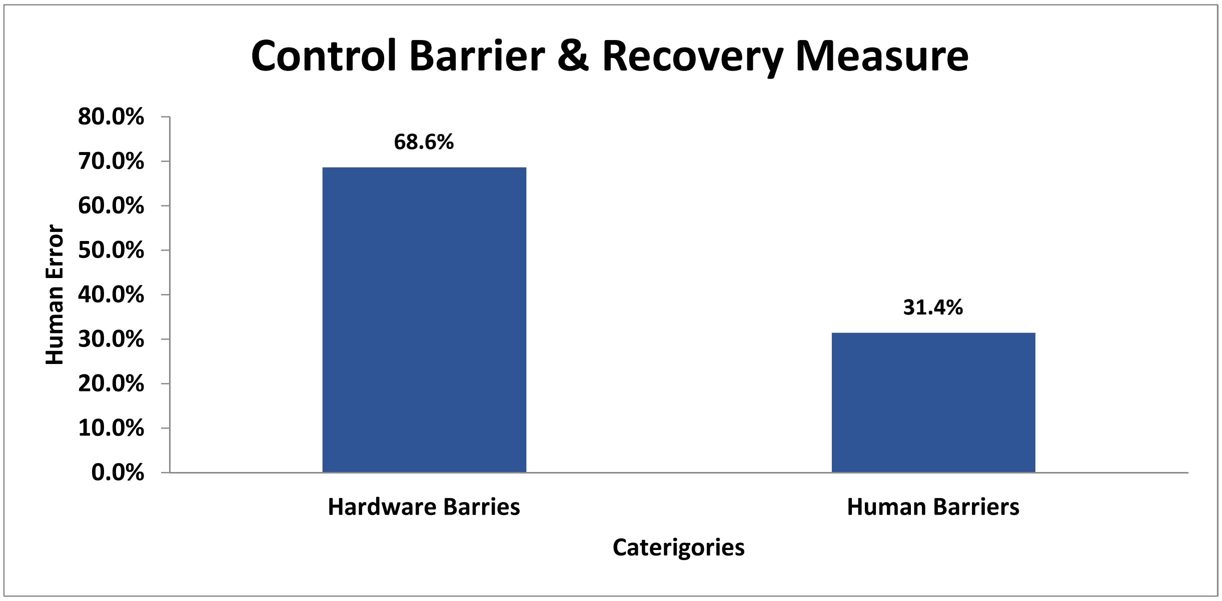

Figure 2.7 Control Barriers and Recovery Measure

An incorrect perception revealed by operator context further led to wrong decisions making and is the major contributing factors for errors that led to an accident (Shorrock & Kirwan, 2002). Performance shaping is also part of Operator context that contribute to human error and it is also significate because, under this study it revealed about 36.1% to the human errors.

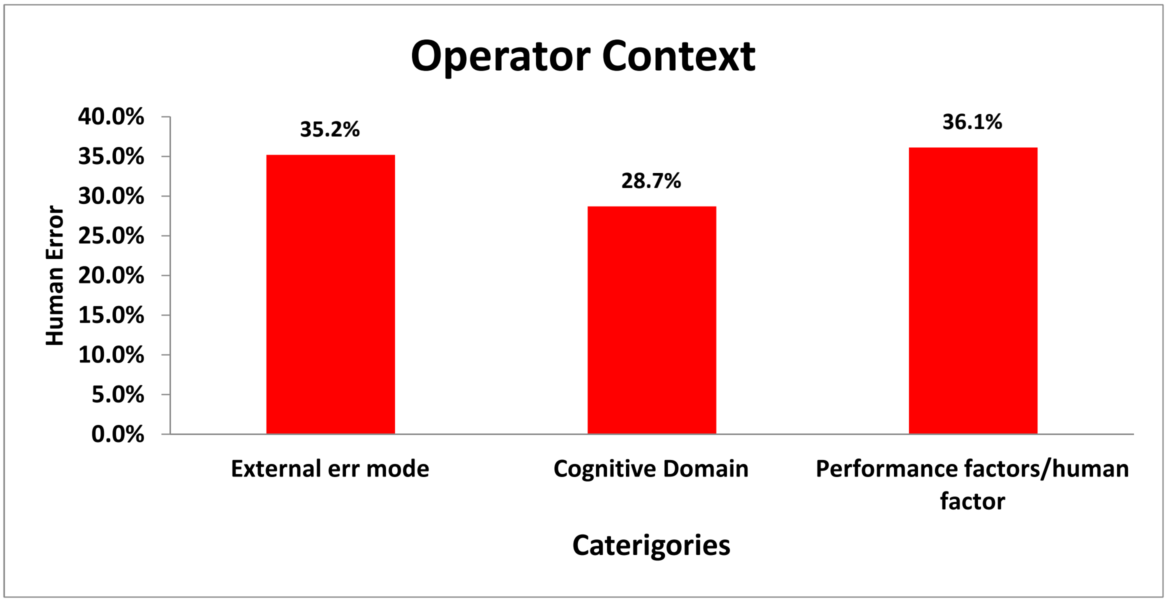

Figure 2.8 Operator Context.

TRACER IN OIL AND GAS (TRACER –OGI)

TRACEr-OGi has flexible taxonomy that could be use as essential tools in the process industries as safety managemet stool because, it enable in identifying human error effectively which are aligned to the context of their jobs, thus it enhance the rate of percentange agreements. Furthermore, operator context and organisational context are also identified. Additionally operators equipment errors are also capture. The coding process has provided a vital information on facilities of oil and gas industries. An investigation of accidents usually provides enough details, and facts on the actually causes of accident together with their locations. These modification has revealed the basic decisions that aid the offshore processing industry as safe environment(Theophilus et al., 2017).

- Result and finding could provide more details on the major precursor cause of accidents on the offshore thereby reveal the predominant incidents for continual improvement through health and safety standards.
- Will facilitate in aiding the enformance of legislation law and safety management framework.
- Results could measure the agreed performance against the standards and legislations(Crewley, 1999).

CONCLUSION

TRACEr-OGI was adaped to Analyse 45 reported Accident published by UK health and Safety executive from 1996 -2005. The results revealed that all the accident are in the offshore facilities with casualities from the operators and other technical personnels. Task Error contribute (64.4%) which affect personnels in the cause of their duty. Persformance shaping revealed (86.7%) which is the most highest errors that contributed to accident within these years after external error mode. Equipment Error constitute 84.4% of error that lead to acccidents which are both from operator and technical personnels and is mostly due to lapses in performing their task. However, cognitive domain cause 68.9% of the errors and this might be due to poor supervision and communications that operator and technical personnel neglect in the decision makings. Equipment error have also contributed 80% of the errors to cause many accidents as a result of mechanical failure.

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