Knowledge Management in Human Error in Accident Prevention

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Abstract— Majority of the major accidents are mostly due to “Human Error” (HE) including those in oil and gas industry either at offshore or onshore worksite. The aim of this research is to develop Knowledge Management (KM) framework and link with Human Error (HE) which can be used to prevent, minimize or reduce major accident among oil and gas industry players in offshore and onshore installations. Objective: Therefore the research is supported by the following objectives (1) To investigate the relationship between the KM factors and HE; (2) To find out what HE factors might contribute to the major accident; and (3) To develop an integrated framework integrating KM and HE to prevent major accident. A research methodology and literature review about KM and HE in major accident prevention was developed on how KM in HE can prevent major accident in oil and gas installations, what are the most suitable KM types, how effective is KM in offshore installations and what is the best method of sharing the outcome from KM in oil and gas installations.

Results: The results, findings and analysis of secondary data will be presented, cross sectional survey questionnaire and the interview data from the view of the Company and Contractors in which is among the primary data of the research. Relevant and related research questions are included in the questionnaire. The results and the conclusions are based on the analysis of feedback from the selected respondents using Statistical Package for Social Science (SPSS) software Conclusion: Possible result of developing KM framework implementation in OSH and integrating HE to prevent major accident in oil and gas installations.

Keywords— Knowledge Management, Human Error, Oil and Gas Industry, Major Accident, Occupational Safety and Health

I. INTRODUCTION

The challenges faced by the oil and gas industry contractor working in offshore construction, the need of Knowledge Management (KM) and its link with the Human Error (HE) that led to major accident which caused single or multiple fatalities. The research aim, objectives and scope are also discussed. Several methods and actions have been proposed in order to improve safety through establishing policies, guidelines and strategies for the organization’s operations for tracking and reporting on sustainable performance. However some of the issues such as lack of KM in safety, reoccurring accidents and no lessons learned database has contributed to the inconsistency trend of safety statistic. Action is needed in oil and gas industry sector to prevent and eliminate injuries, health hazards and damage to property and conserving the environment to ensure consistency and synergy.

II. OBJECTIVE

The aim of this research is to develop KM framework and link with HE which can be used as a guide to prevent, minimize or reduce major accident among oil and gas industry players in offshore and onshore installations. The research objectives are:
1. To investigate the relationship between the KM factors and HE.
2. To find out what HE factors might contribute to the major accident; and
3. To develop an integrated framework integrating KM and HE to prevent major accident.

III. SCOPE

The focus of this study is to develop KM related to HE in major accidents in oil and gas installations. Oil and gas industry players in this study refer to major Oil and Gas Company and contractor. The scope of the research only covers:
1. Oil and gas installation and exclude fabrication yard;
2. HE aspects which result in accidents; and
3. KM framework proposed is not subjected to implementation.
IV. LITERATURE REVIEW

A. Knowledge Management (KM)

Knowledge Management (KM) is a concept in which an enterprise gathers, organizes, shares, and analyses the knowledge of individuals and groups across the organization in ways that directly affect performance, Robert (2001). Meridith (2007) stated that KM is the process through which organizations generate value from the intellectual and knowledge-based assets. KM involves the identification and analysis of available and required knowledge assets and processes to fulfill organizational objectives, Karl Sveiby (2005). Robert (2000) stated KM is simply the transfer of knowledge from one person to another, the result of which enables the recipient to benefit from the collected wisdom of the more experienced members of an organization or group.

Knowledge and information management is becoming so essential for the upstream oil and gas industry. Core workers within the industry are likely to retire in the coming years, which, if not managed properly, could lead to a knowledge gap in the industry. Economic conditions remain tough, meaning companies are going to have to explore ways to use their information to maximize their corporate returns. Developments within the industry following the Deepwater Horizon disaster are also likely to impact on information and KM practices in the country. Report from Deepwater Horizon Joint Information Centre, said that the response team is planning to use KM practices to improve the safety of the Gulf of Mexico for the upstream oil and gas industry. Oil and Gas IQ Report (2013). James (2013) reported in summary of BP’s Deepwater Horizon following to the Gulf of Mexico oil spill in 2010 and hand over $500 million to firms that suffered losses from the tragedy, which resulted in 11 deaths.

The research by EPU (2009) has also reported similar findings in which Malaysian organizations were found to be lagging behind their foreign counterparts from leading economies. Wong and Aspinwall, (2004) introduced a framework for implementing KM in the SME sector, which is centered on six major themes: the types of knowledge to be managed, the socio-technical perspective of KM, the formation of a KM coordinating group, the initiatives to be implemented, a guide to deploying these initiatives, and the tools and techniques to support them.

Rusli et al (2005) stated that KM framework is very important for the organizations that intend to implement KM as guidelines to avoid the errors and benefits in terms of time and cost.

In recent Petronas-related incident involved an oil tanker which caught fire and exploded at the jetty of Petronas Chemicals Methanol Sdn. Bhd. on July 26, 2012. The facility is part of the Ranca-Ranca industrial zone, which is located on the island of Pulau Enoe, near Labuan, Koh (2012). The 38,000 deadweight-tonne MISC tanker was loading six tonnes of methanol when a small fire broke out during a thunderstorm, (The Star Online, 2012). Refer Chart – 1 for Petronas Safety & Health Performance 2009-2012 (Petronas Sustainability Report, 2012). Although Chih-Ping et al. (2002) has conducted a review on KM frameworks, the cases used in the study were only based on highly knowledge-intensive companies. Therefore, KM performed in other industries such as oil and gas industry that require good performance in term of Occupational Safety and Health (OSH) especially to identify on Human Error (HE) are not studied.

CHART - 1 PETRONAS SAFETY & HEALTH PERFORMANCE

*Note: PE0301 covers a period of nine months from 1 April 2011 to 31 December 2011. 2011 covers a period of 12 months from 1 April 2010 to 31 March 2011.
B. Human Error (HE)

Human Error (HE) means that something has been done that was "not intended by the actor; not desired by a set of rules or an external observer; or that led the task or system outside its acceptable limits". In short, it is a deviation from intention, expectation or desirability, (Senders and Moray, 1991). According to Hollnagel (1993), logically human actions can fail to achieve their goal in two different ways: the actions can go as planned, but the plan can be inadequate (leading to mistakes); or, the plan can be satisfactory, but the performance can be deficient (leading to slips and lapses). However, Reason (1990) has an opinion that a mere failure is not an error if there had been no plan to accomplish something in particular. The human factors theory of accident causation attributes accidents to a chain of events ultimately caused by human error. It consists of the following three broad factors that lead to human error: overload, inappropriate response, and inappropriate activities (refer Figure – 1), Accident Facts (Chicago: National Safety Council, 2008).

![Figure 1: Factors that cause human errors. Accident Facts (Chicago: National Safety Council, 2008)](image)

Overload amounts to an imbalance between a person’s capacity at any given time and the load that person is carrying in a given state. A person’s capacity is the product of such factors as his or her natural ability, training, and state of mind, fatigue, stress, and physical condition. Inappropriate Response and Incompatibility is how a person responds in a given situation can cause or prevent an accident. If a person detects a hazardous condition but does nothing to correct it, he or she has responded inappropriately. Human error can be the result of inappropriate activities. An example of an inappropriate activity is a person who undertakes a task that he or she doesn’t know how to do.

C. Major Accident Hazard (MH)

Major accident (MH) is defined as an occurrence including, in particular, a major emission, fire or explosion resulting from uncontrolled development in the course of an industrial activity which lead to serious danger to persons, whether immediate or delayed or inside or outside the installation, or to the environment, and involving one or more hazardous substances, Occupational Safety and Health Act 1994, OSHA (Control of Industrial Major Accident Hazards) Regulations 1996.

The commonly used theories researchers to define major accident were Heinrich's Triangle Theory (1931) and Swiss Cheese Model by Orlandella and James (1990). Both theories can be correlated with Maslow’s Hierarchy of Need (Maslow, 1943) to link with the major accident and HE. According to Smith et al (2001), in the Swiss Cheese model, an organization's defences against failure are modelled as a series of barriers, represented as slices of cheese. The holes in the slices represent weaknesses in individual parts of the system and are continually varying in size and position across the slices. The system produces failures when a hole in each slice momentarily aligns; permitting hazard passes through holes in all of the slices, leading to a failure.

![Reason's 'Swiss Cheese' model](image)
Fig – 2: Swiss Cheese model by Orlandella and James (1990)

While the Heinrich Domino Theory of Multiple Accident Causation developed in 1931 by H. W. Heinrich; states that an accident is only one of a series of factors, each of which depends on a previous factor. According to Heinrich, there are five factors in the sequence of events leading up to an accident. These factors can be summarized as follows, Accident Facts (Chicago: National Safety Council, 2008). Heinrich’s theory has two central points: (1) injuries are caused by the action of preceding factors and (2) removal of the central factor (unsafe act/hazardous condition) negates the action of the preceding factors and, in so doing, prevents accidents and injuries. Accident Facts (Chicago: National Safety Council, 2008).

The accident or incident theory is an extension of the human factors theory. It was developed by Dan Petersen (2006) and referred to as the Petersen accident/incident theory. Petersen introduced such new elements as ergonomic traps, the decision to err, and systems failures, while retaining much of the human factors theory. Petersen also highlighted that a variety of pressures such as deadlines, peer pressure and budget factors can lead to unsafe behaviour and systems failure is important contribution of Petersen’s theory. Following are ways that systems can fail, according to Petersen’s theory:

i. Management does not establish a comprehensive safety policy.
ii. Responsibility and authority with regard to safety are not clearly defined.
iii. Safety procedures such as measurement, inspection, correction, and investigation are ignored or given insufficient attention.
iv. Employees do not receive proper orientation.
v. Employees are not given sufficient safety training.

In conclusion, researcher found there is direct relationship between Peterson’s theory and HE that can be link to the safety aspect of Maslow's Hierarchy of needs. First, overload shows the potential for a causal relationship between HE and safety (accident/incident). Second, system failure establishes management’s role in accident prevention as well as the broader concepts (from the perspective of occupational safety in the workplace). Major Accident Worldwide, Karasek (2011) stated that the top 10 major accidents over the last century have had a major influence on regulatory regimes and industry standards on risk management. Past studies have discovered and the investigations revealed that majority of these incidents are caused by a combination of many factors whose roots can be found in the lack of HE factors (micro and macro ergonomics) considerations.

Meshkati (1991) draws attention that HE and the resultant failures are both the attribute and effect of complicated operational processes, ineffective training, non-responsive managerial systems, non-adaptive organizational designs, haphazard response systems, and sudden environmental disturbances. This statement is in line with McKenzie (2007) who suggested that HE is a symptom of underlying problems, not individuals do not plan to make mistakes whereby they do what makes sense to them at the time of accident. McKenzie (2007) and Pate-Cornell (2006) stated that HE and questionable decisions, flaws in the design guidelines and design practices (e.g., tight physical couplings or insufficient redundancies), misguided priorities in the management of the trade-off between productivity and safety and mistakes in the management of the personnel on board, and errors of judgment in the process by which financial pressures are applied on the production sector (i.e., the oil companies' definition of profit centres) resulting in deficiencies in inspection and maintenance operations. Appendix – 1, Shows summary review of major accidents in oil and gas industry worldwide.

Major Accident in Malaysia, Some major accidents in Malaysia are Tiram Kimia Depot Chemical explosion (1992), Shell Bintulu explosion (1997), Petronas Gas Berhad fire and explosion (2002), Petronas LNG Complex Bintulu fire incident (2003), refinery fire in West Malaysia (1999) and the Fatty Chemicals methanol blast (2006), Petronas LNG Complex Bintulu gas leakage (2009), (Salleh, 2002; Ismail and Stuart, 2005; Zainudin, 2006; Shaluf and Ahmadun, 2006; Utusan Malaysia Online, 2009) and the latest accident Petronas gas pipeline explosion located in between Lawas town and Long Sukang in the northernmost district of Sarawak (2014), (The Star online, 2014). According to Kong (2001), Petronas experienced the worst ever group safety record, with 31 fatalities in 1998 followed by 13 and 17 fatalities in 1999 and 2000 respectively, all involving contractors. There were three fatalities and four major injuries involving contractors’ workers in the Petronas Gas Berhad explosion in 2002 (New Straits Times, 2002; Shaluf and Ahmadun, 2006), and two fatalities and two major injuries involving contractors’ workers in the Fatty Chemicals methanol blast in 2006.

Safety Performance Monitoring by Oil and Gas Players, indicators reveal a significant reduction in fatal accident rate over the past 10 years worldwide. The 2011 edition of OGP’s Safety and Health performance indicators showed that the fatal accident rate was down by 32% in 2011 when compared with the previous year’s performance. This was actual reduction from
94 reported fatalities in 2010 to 65 reported fatalities in 2011. The number of working hours reported increased by 1% to a total of 3,456 million works hours in 2011, Oil and Gas Producer (2013).

However in Malaysia, personal injury performance shows the lost time injury frequency has increased by 12%, and total recordable injury rate is virtually unchanged in 2012 compared with 2011 result. There was no specific study to focus on the link of major accident due to HE in oil and gas industry. Hwee (2013) reported the loss due to major accident in oil and gas industry could be huge as the contract value worth to RM10 billion for 3 years which equivalent to RM1 million loss in a day if accident occur. In year 2013 a total of 63,557 accident cases were reported, an increase of 2,005 cases or 3.26% in comparison to 61,552 cases in 2012. Of these, 56.48% were industrial accidents while the remaining 43.52% were related to commuting accidents. From all the accidents reported, it was found that industrial accidents and accidents while commuting in relation to his employment showed an increase in comparison to 2012, (Source: Social Security Organization of Malaysia, SOCSO 2013).

Major Accident Hazard Review, The review conducted by researcher to understand the gap between KM and HE that link to major accident which some of it explained in earlier section in this paper. There was an issue that was not address such as the link between KM and HE that led to major accident in oil and gas industry.

From the literature review the major installation hazard most common item that can be linked to human error as summarized in Appendix – 2. They are namely such as poor supervision & planning, poor communication, fatigue, workload, training and competency, experience or expertise, familiarization, memory, stress influence of drug and alcohol etc.

The summary of the review can be summarized in Appendix – 3 and Appendix – 5. Major Hazard Installation which the causal factors of major accident can be categorized in three main sections namely as Human Related Error, Mechanical or Equipment Related Error and Other Factor Error. There are more than 10 major hazard installation occurrences over the world and as well as in domestic incident has been identified.
D. Unsafe Act and Decision to Err

Aksorn and Hadikusumo (2007) stated that the unsafe acts of workers are considered as major contributors of work-related accidents and injuries on construction sites. However, not much work has been done to address the reasons why unsafe acts of workers occur particularly in construction industry. This studied found that the top three most frequent unsafe acts are statistically associated with several decision-to-err factors, including lack of management support, management pressure, group norms, overconfidence, being uncomfortable, past experience and laziness.

For many years, safety practitioners have addressed physical preventive measures such as machine guarding, housekeeping and inspection, since poor physical conditions are believed to cause accidents. However, not much preventive work has been done on the human aspects. The fact that many researchers are of the opinion that unsafe acts of workers are the major contributors of accidents and injuries, rather than poor working conditions e.g., Sawacha et al (1999), Abdelhamid and Everett, (2000) Stranks (2000), Haupt (2001), Holt (2001), Goetsch (2005), suggests that there is the need for a change of direction in construction safety research to identify the possible influential factors of workers’ decisions.

As far as HE is concerned, this research also considered to investigate the relationship between the decision-to-err factors and the unsafe acts. This relationship is important for management to study what unsafe acts could occur on the site, to find out what decision-to-err factors might contribute to these unsafe acts and to develop solutions which could reduce such unsafe acts.

Generally, accidents at work occur either due to unsafe working conditions and unsafe worker acts. In construction, it is suggested that unsafe act is the most significant factor in the cause of site accident Sawacha et al., (1999). Abdelhamid and Everett (2000). There is no general agreement on definition of an unsafe act.

However, it has been defined in similar focus on unaccepted practices which have the potential for producing future accidents and injuries. For example, Stranks (2000) gave the definition of unsafe act as any act that deviates from generally recognized safe way of doing a job and increases the likelihood of an accident. Several unsafe acts have been identified by many researchers such as Petersen (1984), Anton (1989), Stranks (1994), Simachokdee (1994), Michuad (1995), Abdelhamid and Everett (2000), and Holt (2001). Table 1 shown the identification of unsafe acts and it coding proposed by Thanet Aksorn and Hadikusumo (2007). Similar table is widely used in construction industry including oil and gas sector in promoting safety program such as Unsafe Act and Unsafe Condition (UAUC). Some of these unsafe acts are:

1. Working without authority on the job can cause accidents since unauthonized workers may lack the necessary skills, or unfamiliar with the job process.
2. Failure to warn or to secure members out of danger is considered as an unsafe act since many accidents occur because workers’ pay less attention to warning or securing co-workers who are working under conditions with high probability of accident occurrence.
3. Working at improper speeds, exceeding the prescribed speed limits, or unsafe speed actions could cause accidents, e.g. workers who handle objects quickly could slip and be injured.
TABLE 1 SHOWN THE IDENTIFICATION OF UNSAFE ACTS AND IT CODING PROPOSED BY THANET AKSORN AND HADIKUSUMO (2007)

<table>
<thead>
<tr>
<th>Coding</th>
<th>List of Unsafe Acts</th>
</tr>
</thead>
<tbody>
<tr>
<td>US-01</td>
<td>Working without authority on the job</td>
</tr>
<tr>
<td>US-02</td>
<td>Failure to warn or to secure members out of danger</td>
</tr>
<tr>
<td>US-03</td>
<td>Working at improper speeds, exceeding the prescribed speed limits, or unsafe speed actions</td>
</tr>
<tr>
<td>US-04</td>
<td>Improper lifting, handling or moving of objects</td>
</tr>
<tr>
<td>US-05</td>
<td>Improper placing and stacking of objects and materials in dangerous locations</td>
</tr>
<tr>
<td>US-06</td>
<td>Incorrect use of tools and equipment, hand tools, power tools and machinery</td>
</tr>
<tr>
<td>US-07</td>
<td>Using defective equipment and tools to work</td>
</tr>
<tr>
<td>US-08</td>
<td>Annoyance and horseplay in the workplace</td>
</tr>
<tr>
<td>US-09</td>
<td>Ignoring to wear personal protective equipment (PPE)</td>
</tr>
<tr>
<td>US-10</td>
<td>Removing safety guards from the workplace or equipment</td>
</tr>
<tr>
<td>US-11</td>
<td>Smoking creating naked flame or sparks in areas where flammable materials are stored</td>
</tr>
<tr>
<td>US-12</td>
<td>Leaving nails or other sharp objects protruding from timber</td>
</tr>
<tr>
<td>US-13</td>
<td>Throwing or accidentally dropping objects from high levels</td>
</tr>
<tr>
<td>US-14</td>
<td>Working under the effects of alcohol and other drugs</td>
</tr>
<tr>
<td>US-15</td>
<td>Improper positioning of tasks</td>
</tr>
<tr>
<td>US-16</td>
<td>Improper posture for tasks</td>
</tr>
<tr>
<td>US-17</td>
<td>Servicing equipment which is in operation</td>
</tr>
<tr>
<td>US-18</td>
<td>Working with lack of concentration</td>
</tr>
<tr>
<td>US-19</td>
<td>Working in poor physical conditions</td>
</tr>
</tbody>
</table>

The decision-to-err can contribute to human errors which could subsequently lead to the occurrence of accidents Wiegmann et al (2005). On the other hand, human errors could stem from the decisions made by workers LaDou (1994). For instance, if a supervisor pressures a worker to increase the rate of production, the worker might choose an unsafe approach rather than a safe one in order to save time and get the job done as quickly as possible. Petersen (1984) proposed a causation model which explains that the decisions of workers to err are due to three main causes:

1. Logical decisions in different situations such as peer pressure, close supervision, management priorities, and personal value system.
2. Unconscious decisions-to-err, which includes proneness and mental problems.
3. Perceived low probability in which the workers believe that they will not have an accident.

Aksorn and Hadikusumo (2007) also found that Decision-to-err factors were gathered from literature review and interview with 20 Thai construction workers. Twenty four factors were identified and grouped under four categories: Personal, Job, Management and Workgroup (see Fig – 3). While, Table 2 shows the identification of decision-to-err factors and their codes.

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Fig – 3 Illustration of the Four Major Factors Contributing to the Decision-to-Err introduced by Wiegmann et al (2005)

TABLE 1 SHOWS THE IDENTIFICATION OF DECISION-TO-ERR FACTORS AND THEIR CODES BY THANET AKSORN AND HADIKUSUMO (2007)

<table>
<thead>
<tr>
<th>Coding</th>
<th>List of factors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Personal Factors (PF)</td>
</tr>
<tr>
<td>PF-01</td>
<td>Laziness</td>
</tr>
<tr>
<td>PF-02</td>
<td>Past experience</td>
</tr>
<tr>
<td>PF-03</td>
<td>Being in hurry</td>
</tr>
<tr>
<td>PF-04</td>
<td>Showing off</td>
</tr>
<tr>
<td>PF-05</td>
<td>Being angry</td>
</tr>
<tr>
<td>PF-06</td>
<td>Being uncomfortable</td>
</tr>
<tr>
<td>PF-07</td>
<td>Effects of using drugs and alcohol</td>
</tr>
<tr>
<td>PF-08</td>
<td>Supervisor's acceptance</td>
</tr>
<tr>
<td>PF-09</td>
<td>Co-worker's acceptance</td>
</tr>
<tr>
<td>PF-10</td>
<td>Overconfidence</td>
</tr>
<tr>
<td>PF-11</td>
<td>Complacency</td>
</tr>
<tr>
<td></td>
<td>Job Factors (JF)</td>
</tr>
<tr>
<td>JF-01</td>
<td>Too much work</td>
</tr>
<tr>
<td>JF-02</td>
<td>Too little work</td>
</tr>
<tr>
<td>JF-03</td>
<td>Time pressure</td>
</tr>
<tr>
<td>JF-04</td>
<td>First Timer</td>
</tr>
<tr>
<td>JF-05</td>
<td>Complexity of job</td>
</tr>
<tr>
<td></td>
<td>Management Factors (MF)</td>
</tr>
<tr>
<td>MF-01</td>
<td>Management pressure</td>
</tr>
<tr>
<td>MF-02</td>
<td>Management support</td>
</tr>
<tr>
<td>MF-03</td>
<td>Supervision</td>
</tr>
<tr>
<td>MF-04</td>
<td>Reward</td>
</tr>
<tr>
<td>MF-05</td>
<td>Penalty</td>
</tr>
<tr>
<td>MF-06</td>
<td>Empowerment</td>
</tr>
<tr>
<td></td>
<td>Workgroup Factors (WF)</td>
</tr>
<tr>
<td>WF-01</td>
<td>Group norms</td>
</tr>
<tr>
<td>WF-02</td>
<td>Group pressure</td>
</tr>
</tbody>
</table>

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E. Major Accident Hazard Review

The review conducted by researcher to understand the gap between KM and HE that link to major accident which some of it explained in earlier section in this chapter. There was an issue that was not address such as the link between KM and HE that led to major accident in oil and gas industry.

HE factors have contributed to the major accidents or disasters such as Chernobyl disaster identified by Stang (1996), fire and explosion at Bright Sparklers in Sungai Buloh by Shaluf et al (2002), Piper Alpha disaster (explosion) by Pate-Cornell (2006), Bhopal disaster by Peterson (2006), Deepwater Horizon blowout BOEMRE (2011), Exxon Valdez oil spill by Coil et al (2012), Bekok C fire incident, Petronas (2010), Fatal incident on pipe lay barge, Shell (2011) etc.

From the literature review the major installation hazard most common item that can be linked to human error as summarized in Table 2.8 below. They are namely such as poor supervision & planning, poor communication, fatigue, workload, training and competency, experience or expertise, familiarisation, memory, stress, influence of drug and alcohol etc.

F. Review Summary

Pate-Cornell (2006) found that the HE factors that contributed to Piper Alpha disaster includes poor supervision and planning, poor communication, relevant training and competency/expertise, failure to follow procedure, lack of awareness, unsafe acts or negligence and failure to observe warning signage of safety devices.

Coil et al (2012) stated that beside all factors stated by Pate-Cornell (2006) in Piper Alpha disaster also found additional HE factors such as fatigue, workload (overload), memory and influence of drug and alcohol has contributed in Exxon Valdez oil spill disaster. The same factors also found by Shell investigation team (2011) in fatal accident on-board pipe lay barge at Batam field and fatal incident hit by watertight door in 2013.

The causal factors of major accident can be categorized in three main sections namely as Human Related Error, Mechanical or Equipment Related Error and Other Factor Error. There are more than 10 major hazard installation occurrences over the world and as well as in domestic incident has been identified.

To achieve the objective of the study, researcher will further investigate the relationship between the KM factors and HE and find out what are HE factors might contribute to the major accident such as unsafe acts and decision-to-err factors as discussed in item D by considering all literature review compilation in this section.

V. METHODOLOGY

The research commenced by reviewing the relevant literature review on construction safety aspects as well as conducting exploratory interviews with 15-20 construction crew (offshore workers) to obtain variables related to unsafe acts and decision-to-err factors.

A. Questionaire Validation

Prior to including them in the questionnaire, the defined variables were validated by a panel of 20 construction safety experts. In this study, construction safety experts are defined as Senior Safety Managers, Safety Engineers and Senior Safety Officers who are or have been involved in managing safety in offshore construction projects for at least 8 years. The experts were asked to indicate the degree of agreement (i.e., 1 = disagree, 2 = somewhat agree, 3 = moderately agree, and 4 = strongly agree) for a set of defined variables whether they are applicable to be used as unsafe act variables and decision-to-err variables. A variable was considered applicable if the mean value is greater than 3 or moderately agree in the measurement scale and the standard deviation (SD) is less than 1.00.

A first draft of questionnaire was designed by incorporating those validated variables and disseminated to a few respondents for pilot test. The purpose of pilot test was to check the appropriateness of questionnaire such as wording, instruction, measurement scale and layout. Certain modifications were made to the pilot study and a questionnaire was then finalized.

B. Survey Form

The survey form for this research is simple and divided into four main sections as follow:

a) A Section: Background of the respondent;
b) B Section: Human Error factors (Unsafe Act and Decision-to-Err);
c) C Section: Factors that influence Human Error (Unsafe Act); and
c) D Section: Open question reasons for factors that influence Human Error.

C. Worksite

In actual data collection, the questionnaire survey was carried out on offshore construction projects on board at main work barge and SapuraKencana 2000 was chosen as worksite for the study which accommodated with more than 270 offshore workers at one particular time with continuously on project execution phase (in operations for a minimum of three months) in year 2015 to enhance accuracy and the level of reliability of the research.

To select the target respondents who are offshore construction workers, accidental sampling was preferable due to time limitation at construction site. A face-to-face questionnaire cum interview was used to ensure high response rate and undistorted information. Jaselskis and Suazo (1994) proposed that face-to-face interview could prevent interviewees from misunderstanding the questions, and thus, ensure the accuracy of the data, as well as avoid embarrassment to illiterate workers. In total, 143 workers have participated in the survey out of 200 issued survey forms.

D. Interview Session

Several interview sessions conducted depending on the target group of workers and working hours. During the interviews, the researcher read out all the questions and marked the scores as rated by the respondents. The questions had to be read out to the respondents because the offshore workers are usually has minimum understanding on this kind of survey. As a result, a total of 143 offshore workers (various disciplines/task) from 290 including executive (profession as engineers and above to represents management) and offshore construction crew (profession as supervisors and below to represent employees) during the period of offshore operations execution projects were individually interviewed, and questions on all unsafe acts were put to each worker to determine the frequency at which he has committed them.

For each unsafe act, a worker had to indicate the degree of influence for the 20 decision-to-err factors. This would require each worker to answer the questionnaire, which could take about one and half hour and two hours to complete. In order to reduce the lengths of survey, the structure of the questionnaire was rearranged to make it easier for the workers to answer the questions by using two-three forced choice items. By this method, a worker basically had to choose only the first two or three unsafe acts which he mostly committed, and indicated the degree of influence of decision-to-err factors for the selected two or three unsafe acts.

By applying the forced choice technique, the researchers could interview an offshore worker within 15 to 20 minutes, and thus, more data could be collected to enhance the reliability of the findings. In order to investigate the unsafe acts, the 143 offshore workers were asked to rate scores to indicate the frequency of the unsafe acts which they commit on the construction site where they were then engaged.

The five points rating scale (i.e., 1 = never performed, 2 = rarely performed, 3 = occasionally performed, 4 = often performed, and 5 = usually performed) was used to measure the frequency. Thereafter, each respondent was asked to indicate the reasons for doing such unsafe acts, and to rate the degree of influence. The four rating scale (i.e., 1 = not influential, 2 = little influential, 3 = moderately influential, and 4 = strongly influential) was used.

E. Data Analysis

It should be noted that when selecting a data analysis technique, a researcher should make sure that the assumptions related to the technique are satisfied (i.e., normal distribution, independence among observations, linearity, and lack of multi-collinearity between the independent variables, etc.).

Analysis of interview data commenced after interview notes and tape recorded interviews were fully transcribed. First, for each of the 20 variables (Section B) of HE factors (unsafe acts), an interview question probed the complexity and range of activities. Second, for 24 variables (Section C) a further question probed the perceived importance of the variable for a factors that influenced HE.
In the analysis of the data, interviewee's ratings were triangulated with other data collected by the researcher to settle on a final grading. Throughout the discussion, quotations are shown in direct quotation marks. Bias has been dealt with through the triangulation of respondents' comments with other data sources.

The obtained data was coded into a data file and analysed using the Statistical Package for Social Science (SPSS) or which are using Likert scale and frequency method and or simple data computation using common software available in the market. Several statistical techniques were used in this study. Descriptive data analysis (i.e., mean score) was used to summarize and describe information about variables in the dataset.

The Kruskal-Wallis test, a nonparametric technique, was applied to test whether or not the several groups of workers have similar patterns of unsafe practices in doing jobs. The one-sample t-test was used to examine which factors highly influence the workers' decisions to commit unsafe acts.

Furthermore, the multiple-regression analysis was employed to derive the relationships among several decision-to-err factors and unsafe acts. This technique is helpful in removing insignificant factors which have less effect on the occurrences of unsafe acts and remaining the significant ones. In addition, the level of significance chosen for the study was $\alpha = 0.05$.

F. Result

Result of the study will be discussed in chapter 4. In this study researcher will try to avoid reaching no result which can mean that actions, steps and research method are inefficient, ineffective, meaningless or flawed. Hiccups along the process may expected especially to gather secondary fact or data from authorities or government agencies which may still under legal obligations to avoid implications or confidentiality policy set by the main player in oil and gas industry players.

G. Conclusion

The quantitative questionnaires data from the questionnaires will be analysed using the standard method of SPSS. Based on the discussed research methodology method and data collection the objective of the study should be able to achieve

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Include author bio(s) of 200 words or less.

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