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DEDICATION

I dedicate this thesis to my Father who passed away, my mother and entire Family. Thank you all for going through this journey with me.

I love you all so dearly.

Acknowledgment

I will like to show my gratitude to God for the Grace and strength to complete this thesis. It has been an honor getting guidance, motivation, and advice from my supervisor Professor Willy Røed and I am extremely grateful to him for his patience and time spent on me throughout my thesis writing period regardless of his busy schedule. I will also like to thank my family and friends for their encouragement, moral and financial supports during this period. Special thanks to my Sister Chi Elvire and my Friend James Badu for their endless encouragement and directions to complete my thesis work and studies.

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ABSTRACT

This thesis focuses on occupational safety, looking at what characterizes ergonomic risk in the Norwegian petroleum industry from Major accidents that also threaten human life. It also looks at the different ergonomic assessment methods used for both offshore and shore workers which could lead to Musculoskeletal disorders. The objective is to see how effective and reliable these assessment methods are in identifying postural risk for personnel. The three assessment methods discussed in this thesis are the Rapid entire body assessment method(RULA), the Rapid upper limb assessment method(REBA), and the Ovako working posture assessment method(OWAS). These three methods have a common assessment approach of using a coding format and categorization table to identify postural risk and for decision making. The RULA and REBA methods are specific for particular body parts to be evaluated, however, the OWAS method puts into consideration postures that affect the back, legs, arms, and weight. It is for this reason that this thesis will be using the OWAS method as an example to illustrate how an ergonomic risk assessment is carried out. It could be seen that the OWAS method did not prove to be a very reliable assessment technique for ergonomics, hence a discussion is later made on how this method can be improved for better postural risk identification.

Relevance to the industry

Occupational injuries have become a major health problem for not just the petroleum industry, but most companies and other industries. To better manage this problem, will require an effective assessment technique to evaluate the risk personnel is exposed to at the workstation.

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ABBREVIATIONS

SRA: Society for Risk Analysis

PSA: Petroleum Safety Authority

PF: Frequentist Probability

OSHA: Occupational Safety and Health Administration

MSD: Musculoskeletal Disorders

OWAS: Ovako Work Posture Analysing System

REBA: Rapid Entire Body Assessment

RULA: Rapid Upper Limbe Assessment

CHAPTER ONE: INTRODUCTION

The introductory chapter of this thesis consists of four parts. The first subchapter gives a background for the topic chosen and why the topic is relevant. The second subchapter givesa brief explanation of what motivated the choice of topic. The third subchapter presents theresearch questions and lastly, the fourth part tells how the thesis will be organized.

1.1 BACKGROUND FOR CHOSEN TOPIC

Amongst many other industries in Norway, the Norwegian oil and gas industry seems to be one of the leading industries in the country. This industry has a record of being the 8th largest oil industry and the 3rd largest producer of natural gas in the world (Andrew McKay,2019). Though this industry has boosted the economy of Norway, it still stands as one of the riskiest jobs to be carried out. Major accidents caused as a result of hydrocarbon leakage which can lead to explosions and fire outbreaks, leading to fatal injuries and death in worst scenarios, and other activities such as exploration and drilling, heavy oil processing,pipeline operations, stands as a threat to occupational health and safety of workers (RonaldW.Mcleod, 2009) because accidents of this nature do not only affect an individual but its environment as well.

However, this thesis focuses on the ergonomic risk factors employees are exposed to in thisindustry and the risk assessment methods in identifying the health risk. Ergonomic deficiency is one of the major causes of workplace hazards. This can be because of poor communication between managers and workers, lack of training done to master machines and safety rules, inadequate skills, and limited resources to ease the work task. Ergonomic hazards can result in poor health conditions such as back pain, body aches, fatigue, stress, and uncomfortable working postures. Poor human-machine system designs, inappropriate management, a mismatch between workers' abilities and job demands, and ill-structured jobscan be the major cause of the injuries and disabilities encountered in this industry (Ashraf A.Shikdar & Naseem M.Sawaqed; 2004). Injuries resulting from ergonomics most often affect employees who are exposed to the lifting of loads, painting, working on gratings, working on heights, manual handling, confined space, electrical exposure, rigging, exposure to pressure, and stored energy, mixing/handling chemicals, welding, etc.

1.2 PROBLEM STATEMENT

Despite all the complains made by employees regarding their work postures, it still seems difficult for companies to identify and mitigate the riskiest ergonomic factors workers are phasing in this industry, even the present safety measures implemented don't seem to do aperfect job. Thus, It is in this regard that this thesis will be looking at some risk assessment techniques which are practiced in the petroleum industry in identifying the risk work postures employees are exposed to, with a special focus on using the OWAS assessment method and to see if this method is effective enough to identify wrong work postures.

1.3Organization of chapters

The first chapter introduces the thesis, stating the thesis problem and how the work will bearranged.

The second chapter explains the Risk concept, a presentation of major accidents, an introduction to the concepts of Occupational Safety and Ergonomics, with its characterization.

The third chapter gives an illustration and presentation of the three Ergonomic risk

assessment techniques, with a special focus on the OWAS method with the use of an example.

The fourth chapter presents recommendations to improve the OWAS method.

The fifth chapter will be on a discussion that links the assessment carried out in the example in chapter 4 with the theoretical framework of the thesis and a conclusion of thethesis.

1.4 RESEARCH QUESTION

The thesis is meant to look at the various ergonomic risk assessment methods, with a specialfocus on the OWAS assessment method, to see how effective this method can be in addressing the occurrence of occupational accidents at work.

The following research questions will help answer this problem:

What characterizes ergonomic risk in the Norwegian oil and gas industry?

How is the OWAS method used in ergonomic risk assessment?

What improvements can be made to the OWAS assessment?

CHAPTER TWO: THE CONCEPT OF RISK

Many definitions have been gotten to better explain the concept of risk and most of them are based on expected values and probabilities. In summary, "Risk can be defined as an event or consequence of an event which is subject to uncertainty, and of which something of human value is at stake (Aven,2011). To understand the risk attached to the occurrence of an event, two aspects are considered;

A consequence of an event

The uncertainty on the consequence of an event

Thus, the risk evaluation becomes dependent on the available knowledge (Aven,2016). InAven 2011, we are made to understand risk will always be dependent on the available knowledge. The point he tries to bring out is that the concept of risk must be based on a level of uncertainty, where the probability cannot be quantified and is depending on the context, the uncertainty is a result of a lack of knowledge and information (Aven,2011).

The way people turn to react to risk depends on their perception which could be based on experience, culture, believes, and attitudes. The most common way to influence the perception of people will depend on how risk managers present the risk situation to those involved and the surrounding environment, which brings us to the concept of risk communication. This is a key process vital for the risk management team in decision making. The basic concept in risk is that it is a mental concept that exists when we consider a specificactivity. And there are values at stake (consequences concerning what people value) and there are uncertainties about what the consequences will be. We can measure the risk by representing or modeling the values at stake and the uncertainties involved. The measure used is intersubjective but not objective. Probability models can be used to represent stochastic uncertainties. The probability model used is conditioned on the assessor's knowledge for the event to occur. This knowledge can be weak or strong (Aven, 2020, p. 36). Aven (2020) opined that a probability model is a set of frequentist probabilities. Thus, a frequentist probability Pf(A) of an "event A" can be interpreted as the fraction of times "event A" occurs when considering an infinite population of situations or scenarios similar to the one analyzed.

Probability models and frequentist probabilities needto be justified but usually, they cannot be meaningfully defined as Pf(A) is unknown (Aven, 2020). This results in estimation and uncertainty assessment of Pf(A). Subjective probabilities including interval probability is a tool used to express the assessor's uncertainty and beliefs about unknown events and quantities (Aven, 2020). Thus, a probability (including interval probability) for say "event A" is based on some knowledge (K).This can be expressed as P(A|K). Aven (2020) argued that this knowledge should be considered with probability (interval probability) to express the full characterization of the uncertainties on the unknown events and quantities. Subjective probability is interpreted regarding a standard. For instance, an assessor can assign the probability of 0.5 for event A to occur. This means that the assessor has the same degree of belief that "event A" will occur as randomly drawing a black ball from an urn which comprises 100 balls of which 50 are black. When it comes to probability interval, then the assessor is not willing to be more precise than the interval specified (Aven, 2020). Thus, a specified interval of [0.2, 0.3] means that the assessor has the same degree of belief that "event A" will occuras randomly drawing a black ball from an urn which comprises 100 balls, where 20 to 30 are black and the exact number is not specified.

The SRA (2015) defined risk as the possibility of an unfortunate occurrence, the potential forrealization of unwanted negative consequences of an event, and associated uncertainties.

The concept of risk has two main aspects to be taken into consideration, which are the consequence of an event related to something of human value (human life), and the level ofuncertainty (possibility, potential).

Barrier, risk source, threats, hazards, security, and safety are a few amongst the other aspects which has been used to understand the framework for describing risk (Aven,2020)

BARRIER: This can be defined as a protective measure set in place to prevent the occurrenceof an event. Most production companies are required to have such installations to prevent an unexpected outboast of an event that can cause harm to employees or the surrounding environment. An example could be the installation of a warning machine to signal an overheated engine, to prevent a fire outbreak. A barrier system could also be set for the reduction of consequences due to the occurrence of an event. Therefore the barrier system has a strong rule in determining how much consequence can be realized by either detectinga threat or by reducing the consequence of the occurrence of an event (Aven,2020).

RISK SOURCE: A risk source could be an action, component, or system which on its own or with the combination of another element can result in an event that can cause a consequence affecting something of human value. Exposure to noise and too much light could be a risk source on its own. Same in a petroleum production industry, failure of onevalve or a combination of another element failure could lead to an event (Aven,2020).

THREATS /HAZARDS: A threat could be the event(A) that can result in a negative outcome, i.e., a component or element can pause as a threat in a production environment. The threat could as well be used about environmental or societal security when talking about risk, depending on the scenario. This could be an inferred intention stated to create fear, pain, orharm an individual or society (SR A2015), and can be related to terrorist threats before they execute an attack. Hazards, on the other hand, is s a risk source whereby its potential consequence could result in psychological or physical damage(Aven,2020).

According to NORSORK Standard Z-013 (Standard Norway 2010), QRA has been the most frequently used assessment method for most petroleum industries offshore especially for therisk assessment for major accidents. This is an assessment method that has to do with the evaluation of risk and analysis of risk, and it is often also referred to as the Probabilistic risk assessment method because it identifies, analyzes, and evaluates risk (W. Røed, 2020 Vol 1). This method is meant to identify hazards and for the description of risk to personnel, environment, and assets, and its analytical elements are best described with the use of the Bow-tie diagram as seen below. The Bow-tie diagram gives a better presentation of how theelements of Barrier, Risk source, threats/hazards, and consequence are used in understanding how to manage risk.

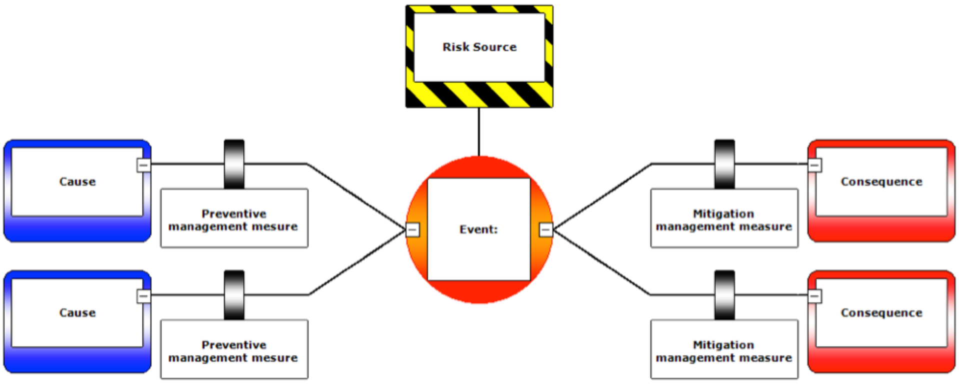


Fig.1. Bow-tie Diagram (CGE Risk management solution)

SAFETY /SECURITY: Safety could be referred to as staying away from acceptable risk. It can always be related to risk because a low risk dictated will mean a high level of safety and viceversa. When restricting the concept of risk to intentional unwanted acts carried by humans,security could as well mean avoiding unacceptable risk (Aven,2020), and just like safety, a high level of risk will mean a low level of security and vice versa.

In the context of security, the values, threats, and vulnerability have to be considered (Amundrud et al, 2017). Whereby, the values at stake (assets, human life) are identified together with the consequence (C) attached to the occurrence of the event (A). The threat(T) could be defined as the event (A)and the Risk Source (RS). When there is a threat identification, the consequence and uncertainties are looked in to and this is referred to asvulnerability (Aven,2020).

When defining risk (Aven,2020), the specification has to be made on these fundamental aspectson the threat T, which could be RS or A, the Consequence(C)using a measure of uncertainties(Q), based on the available background knowledge(K).

RISK = (T’, C’, Q, K)

The PSA, which is a Norwegian state administrative body in charge of safety, working environment, emergency preparedness, and security in the Norwegian petroleum sector, strives to ensure companies maintain a good working environment for personnel to avoid workplace injuries and illnesses. This body believes that with the help of good management, companies will be able to better manage the dangers workers are exposed to,hence avoiding unacceptable risk workers health such as noise, heavy and difficult work environment, hazardous chemicals, etc. This body provides guidelines on risk reduction and preventive measures for example, before providing eyeglasses to protect the eyes and act as a barrier against eye damage, technical measures could be set in place to reduce the lightlevel and the same goes for implementing technical measures to reduce the noise level before providing ear covers as a barrier measure to prevent eye damage. This body believes they can assist petroleum companies to manage their risk exposures through effective communication to share their ideas and barrier measures to manage working environment safety. In some cases, they go as far as providing safety equipment if the company fails to do so. The PSA does not only focus on the working environment, but they also act as inspectors for major accidents because they try to see how the working environment can affect major accident risk(PSA Norway,2021).

2.1 PRESENTATION OF THE CONCEPT OF MAJOR ACCIDENTS IN THE NORWEGIAN PETROLEUM INDUSTRY

Vinnnem et al.(2010) make us understand there is no accepted definition of the concept of major accidents. A major accident in the oil industry can be said to be an accident that occurred and went out of a controllable situation, which eventually led to the death of many people and destroyed the environment.
According to the Petroleum Safety Authority, Norway (2019), "Major accident means an acute event such as a major spill, fire or explosion that immediately or later causes several serious injuries and/or loss of life, serious damage to the environment and/or loss of major economic values. “Such accidents usually have socio-economic and societal drastic consequences. The occurrence of most Major accident hazards in this industry is caused by hydrocarbon leakage which is linked to either Gas leakage, liquid, or multiphase leakage, resulting in explosions and fire outbreaks, leading to fatal injuries and death in worst scenarios. Amongst the three mentioned leakages, gas leakage is recorded as the most dangerous that can lead to a wild explosion beyond control and can affect the environment as the gas spreads in the cloud (Petroleum Safety Authority, Norway,2018 b). Other activities such as exploration and drilling, heavy oil processing, pipeline operations also stand as a threat to the occupational health and safety of workers (RW.Mcleod, 2009). This kind of accident does not only affect an individual, but its environment as well, and some hazards which can affect the environment is a result of pipeline and riser leakage, accidents to shuttle tankers causing spills, large spills from blowouts or explosions, etc. Between the years 1966 and 2018, 86 fatal

accidents were recorded with 283 fatalities (Vinnem, W.Røed 2020). However, in the last decades, a decrease in the frequency rate for major accidents was noted. Fatal accidents have occurred in different platforms on the Norwegian continental shelf, such as product installation, mobile installation, attendant vessels, which happened to be the major platforms that have experienced the highest frequency rate of fatal incidents and platforms like helicopter accidents through maintenance process or transportation to shore, diving and pipe laying vessels have a lower frequency of major accidents and though helicopter crash also had a record of 2 incidents where it crashed and 1 case of maintenance accidents, accidents related to personnel being hit or crushed by moving or falling objects has been recorded lately as the major cause of accidents in this industry with a record of 22 fatalities within the period 1986-2018.

The most used risk assessment approach for major accidents has been the ISO 31000 standard: Risk management and guidelines. The same approach was used in the NORSOK Z-013 standard: Risk and emergency preparedness analysis.

The ISO 31000 standard comprises different elements as presented in Fig 2, this standard shows a risk management process that can be applied in strategic decision makings by top management and can also be used for an offshore installation process when treating operational risk.

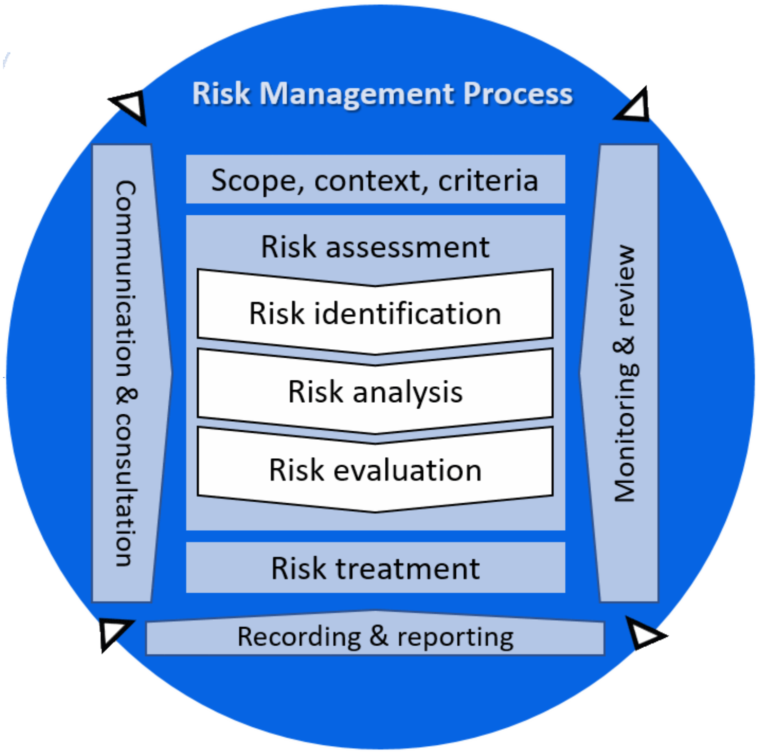


Fig. 2 ISO 31000 risk assessment diagram

Source: CGE Risk,202

The risk management process used in ISO 31000 includes the following stages:

Establishing the context: This is about defining the objective of the organization and thescope of the risk management process and stipulating the risk evaluation criteria.

Risk Identification: The process of identification is to identify the sources of an identified hazard and events that can lead to its occurrence, together with its potential consequences.This process also helps in identifying some risk-reducing measures.

Risk Analysis: This process focuses on identifying the potential cause of an event, assessing the probability and consequence of occurrence. The consequence analysis is to identify the outcome of an event that will affect the employees and the surrounding environment.

Risk Evaluation: This process helps in decision-making based on the risk analysis carried out.It brings out the various risk that needs treatment and which has to be prioritized. In some cases, the evaluation could result in a decision of more analysis to be carried out again.

Risk Treatment: This process aims at changing the gravity or likelihood of the consequencesof an event by selecting a treatment option and implementing it. Sometimes the company may decide to share the risk with other parties through insurance.

Monitoring and Review: It ensures risk management plans, frameworks and policies are still appropriate for use. This process entails reviewing the risk management framework based on the context to ensure they are effective to still be implemented.

Communication and consultation: This is the part where internal and external stakeholdersget involved to ensure the risk assessment process is suitable or needs to be improved for the purpose intended through effective communication. For communication to be effective,there must be a high level of trust and openness amongst decision-makers and stakeholders. The information shouldn’t only be communicated to stakeholders or

employees, but the surrounding environment also must be informed of the risk threat.

In some years back, there was a greater concentration on the occurrence of major accidentsin this industry, neglecting accidents caused by occupational hazards. However, in recent years, most of the accidents recorded in this industry have been more because of occupational hazards and not major accidents. Managers have turned to focus more on the financial benefits for the company, than the HSE of their employees. There has been an increase of MSDs in workplaces because of poor working postures practiced by an employee,which in turn increase the percentage of occupational injuries in industries. It is in this regard that this thesis will be focusing more on work postures practiced by workers that expose them to MSDs and the various assessment methods been used to analyze the riskof ergonomic accidents.

The concept of risk can be applied in all fields such as safety engineering, transportation,security and supply chain management, finance, political and environmental risk management, etc (Althaus, 2005).

It is in this regard that this work will be focusing on occupational safety management. This isa part of risk management where the value of human life is of utmost importance and consideration to ensure a good and safe working environment for pers

2.2THE CONCEPT OF OCCUPATIONAL SAFETY

In 1970, an Occupational Safety and Health Act was passed in the United States, of which itsgoal was to ensure a safe and healthy working condition for workers to reduce the occurrence of occupational accidents. This Act also came up with the establishment of the occupational safety and health Administration (OSHA), to make and pass out safety standards for organizations to implement. On April 28.1971, OSHA was officially assigned to be a federal body in charge of workers' health and safety. In 1972, OSHA built a training institute to educate state consultants, private sector managers, and non-OSHA personnel onhealth and safety management standards, for them to educate their employees as well (EHSinsight resources; October 17, 2019).

According to Faith Eyayo,2014 Occupational hazards can be divided into two categories, are safety hazards and health hazards. Safety hazards are hazards that can cause an accident that will physically injure workers and while health hazards are hazards that will result in an illness due to extreme exposure to some poor conditions. Looking at the safety hazards, there are different types of accidents and risk factors that contribute to the number of fatalities and death rates in the oil industry. Some of the most common accidentscan be caused a result of equipment failures, falls, and exposure to heavy machines.

Workers in this industry are usually exposed to a lot of heavy equipment either by pulling a pipe,

transporting pipes, drilling, or carrying out other related work tasks linked with heavy equipment. Accidents in such cases are either caused as a result of lack of experience, bodyfatigue, mechanical failures, poor maintenance of equipment, or poor safety inspections.
When such accidents occur, it will either lead to temporal or permanent damages such as limb and bones injuries on the hands, legs, fingers, toes, and joints (Sutliff &Stout).

All these comprise ergonomic risk factors which expose workers' health to risk. These factors are factors that will affect the relationship between the work task and the employeeeither through the lifting of loads, bending, pushing and pulling heavy equipment, working in awkward body postures, and performing the same duty task as a routine (Pedro. M. Arezes)

Since 1992, work-related diseases amongst workers in the Norway Petroleum industry havebeen reported by physicians to analyze the rate of musculoskeletal disorders (MSD) in this industry. According to data collected from the petroleum safety authority registry of work-related diseases, statistics from (1992 – 2003), stated that 3131 cases of MSD were reportedas it varied from year to year. Below is the mean percentage of cases recorded:

Upper limb – 53%,

Back disorders – 20%, Lower limb16%,
Knee disorder (12%),
Maintenance work –40%,

Catering – 21%.

The frequently reported complaints they recorded were based on repetitive work, high physical workload, walking on hard surfaces, and climbing stairs and ladders. According tothe petroleum safety authority registry, this information was recorded based on the employees' age, workers' diagnosis, occupation, and description of types of exposure thatmight be causally linked.

In most industries, the role of human beings is still highly used in carrying production processes, especially activities related to manual labor. At the workstations in the oil andgas industry, manual material handling (MMH) is highly practiced. Though this can be stressful, it also has advantages like high flexibility and cost reduction for the industry. Ashuman beings, we all have limitations to what we can resist, therefore it is important to know if there is a balance between a worker's ability to work and the work task demanded.

In the past years, many work posture analysis methods have been discovered, thus this makes us realize work posture is an important issue that needs study. Work posture analysisstarted with the application of the OWAS method. This method (OWAS) was first applied in a Finnish steel company Ovako Oy in the year 1977(Medan,2018). Aside from the OWAS method, many other Ergonomic risk analysis methods for work postures were created such as the Rapid entire body assessment method (REBA) and the Rapid Upper Limb Assessment methods (RULA).

Occupational accidents which affect the health and safety of employees are caused by different causal factors such as Ergonomic, chemical, physical, biological, and psychologicalfactors.

Ergonomic Factors

Ergonomic risk factors are factors derived from work postures that affect the back, legs, arms, and neck, which can lead to musculoskeletal disorders, hence occupational injuries.

Ergonomic deficiency is one of the major causes of workplace hazards. This can be because of poor work postures practiced because of inadequate training, poor relationships betweenmanagers and workers which can lead to psychological trauma, lack of training done to master machines and safety rules, inadequate skills, and limited resources to ease the work task. Ergonomic hazards can result in poor health conditions like back pain, body aches, fatigue, stress, and uncomfortable working postures. Poor human-machine system designs, inappropriate management, a mismatch between workers' ability and job demands, and ill-structured jobs can be the major cause of the injuries and disabilities encountered in this industry (Ashraf A.Shikdar & Naseem M.Sawaqed; 2004).

Injuries resulting from ergonomics most often affect employees who are exposed to the lifting of loads, painting, working on gratings, working on heights, manual handling, confined space, electrical exposure, rigging, exposure to pressure, and stored energy, mixing/handling chemicals, welding, etc. Exposure to ergonomic factors will expose employees to high health risks as a result of injuries such as Back strain, burns, crushing/trapping, drowning, falling, shock/electrical, slipping/tripping, suffocating, skin irritation, high noise/vibration, cuts, fire/explosions/ignition, etc(Biman Das and Arijit K.Sengupta, vol 27;1996).

Physical Factors

Physical factors are factors that can harm the human body without coming in direct contactwith equipment. In most cases, physical hazards are caused because of exposure to vibration, noise, and microclimatic conditions due to extreme heat or cold.

Chemical Factors

Chemical factors are caused because of exposure to chemicals. The gravity of its effectdepends on the amount of intake of this chemical and the duration of exposure to it. According to the national transportation safety board, silica dust is the cause of most chemical hazards in the oil industry.

Biological Factors

Meanwhile, these chemical factors can also lead to Biological hazards because an extreme intake of a chemical can lead to diseases that will affect the lungs, skin, and other body organs, depending on the amount of intake and the duration of exposure to the chemicals.

Psychological Factors

Psychological factors also affect workers' health. This happens when a lot is demandedfrom a worker, much concentration with irregular working hours alone working environment, long work hours, and the relationship between employer and employee.

These factors will determine a worker's psychology at work (see; Evaluation of OccupationalHealth Hazards among Oil Industry Workers: A Case Study of Refinery Workers)

Musculoskeletal disorders have been the major kind of injuries personnel have been exposed to about occupational safety. This is a form of disorder that affects the muscles, ligaments, joints, cartilage, bones, and blood vessels, and they are mostly caused by poor work conditions. This form of the disorder usually occurs slowly in a long run and is not just an effect that is visible immediately. The association of occupational safety and health (OSHA) defines MSD as a disorder of the ligaments and joints and Some of the symptoms of tendon MSD include pain on over contracted muscles, tenderness, swellings, partial laceration, Ligaments on the other hand, which are connective tissues linking two bones or cartilage provide stability to the joints, thus holding the bones together, for example, ligaments on the knee. Blood flow is faster in muscles than in the ligaments. Hence, injuries on the ligaments are to be considered serious because they take a longer time to heal(Amit Bhattacharya & James DMcGlothlin)

Standing (and walking)				Kneeling or crouching		
1			Standing & walking in alteration, standing with support	12		Upright
2			Standing, no body support (for other restrictions see Extra Points)	13		Bent forward
3		a	Bent forward (20-60°)	14		Elbow at / above shoulder level
		b	with suitable support			
4		a	Strongly bent forward (>60°)			
		b	with suitable support			

Fig.3 Activity Recognition for Ergonomics Assessment of Industrial Tasks With Automatic FeatureSelection, 2019.

2.3 MUSCULOSKELETAL RISK FACTORS

Certain risk factors such as posture, force, repetition, and duration are set as contributors toWMSDs. Exposure to any of these factors can lead to an injury

POSTURES

A neutral posture is a posture that gives little or no stress to the worker while carrying a task. This posture will place no amount of heavy pressure on the muscles and nerves, thuspreventing excess contractions that can cause harm. This is a posture where the neck, shoulders, and arms are relaxed while work is been carried out.

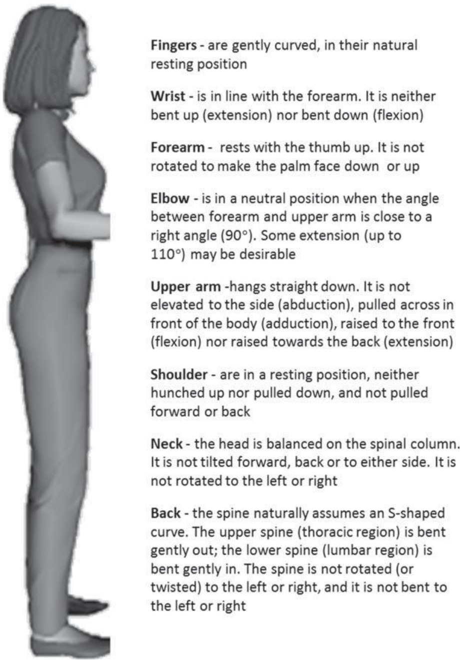


Fig.4 Standing neutral postures (Adapted with permission from The ErgonomicsImage Gallery)

Awkward Postures, on the other hand, make the worker stress their nerves and muscles above the normal limits, thus leading to compression and irritation of nerves and tendonsand these are the greatest postures that lead to MSD. Activities of such postures include(Armstrong,1889);

Raising hands above head and shoulder
Kneeling and squatting
Working with back and neck bent
Sitting with feet unsupported

Fig.5 Awkward work postures(*Adapted with permission from The ErgonomicsImage Gallery*)

These awkward postures are more strenuous because the muscles and tendons will befighting to maintain a balance with the posture.

REPETITION

Continuous repetition of a particular task over and over for a long duration of time will gradually begin to affect the muscles in a long run. Repetition carried out on other risk factors such as awkward work postures will increase the exposure of workers to MSDs.Forexample, repetition of bending of the trunk will lead to low back pain in a long run(Andersson,1979).

FORCE

Activities involving lifting, pushing and carrying involve the usage of force, and handling of heavyweight is considered a cause for back pain (NIOH,1981). This has to do with the amount of physical effort used in carrying out a task. A task that requires high force eventually will stress the muscles and joints above their limits, leading to tiredness, and prolonged exposure to such a work task will strain and damage the muscles and joints in a long run. Tasks that involve the use of hand tools are considered to increase MSD as theycan be heavy to hold, slippery, or vibrate, thus increasing the amount of force used in holding the tool (Andersson,1988).

DURATION

Duration refers to a period. Exposure to risk factors over a long period does not give enoughtime for the muscles to rest or recover when carrying out a task. Thus, a long duration on a task increases the risk factors of WMSDs. Static postures over a long period can lead to muscular discomfort (Astrand and Rodahl, 1986). A typical work schedule in the oil industry will be 8hrs of work for those in the offices which starts from 8 am to 4 pm.,5 days per week, meanwhile, a 12hrs work time is scheduled for those on the rings divided into 2 shiftswhere the first starts from 6 am to 6 pm and the second shift starts from 6 pm to 6 am, though taking their normal breaks. Exposure to an uncomfortable work environment for such a long time without a doubt will lead to the poor health condition of the workers (Biman Das and Arijit K.Sengupta, vol 27;1996).

Thus, tasks that require constant sitting, standing, kneeling increase the risk of MSD, especially leading to low back pain(Magora, 1972).

Aside from the other forms of occupational accidents personnel experience, this thesis chooses to focus on ergonomics because of the increased rate of complaints gotten from personnel related to back, neck, arms, and leg pains they get as a result of poor work postures practiced over a duration of time. Some workers feel managers focus more on the benefits of the company and less attention is given to occupational health.

2.4 THE CONCEPT OF ERGONOMICS

Ergonomics is an applied science meant to take care of human health at the workplace, to reduce or limit the occurrence of workplace injuries or disorders, reduce productivity and life quality. The international labor organization states "Ergonomics is the application of human biological science in conjunction with the engineering science to achieve optimum mutual adjustment of humans to his /her work, the benefits being measured in terms of human efficiency and wellbeing''. Thus, ergonomics tries to make sure the human ability and capabilities are equivalent to the work task. Failure in ergonomics will lead to problems such as Musculoskeletal disorders, visual disorders, vascular disorders, hearing disorders, and skin disorders (International labor organization, 2008). This concept is divided into twomajor branches as explained below.

HUMAN FACTORS OF ERGONOMICS

This is concerned about the psychological effects work stress can have on a worker, affecting his mental health and decision making. When a worker is not satisfied with his jobeither as a result of working conditions or employee and manager relationship, this will not only affect his mental health but will also reduce his productivity to the company. Thus workers need to be psychologically satisfied with whatever task they are assigned to and dotheir jobs with passion.

INDUSTRIAL ERGONOMICS OR OCCUPATIONAL BIOMECHANICS

This applies to the physical aspects of work related to work postures, force, and repetitionof duty. A combination of Force + Posture +Repetition +Duration is a high contributing riskfactor to MSD as mentioned earlier. A reduction of any of these risk factors will be of greathelp to the workers

However, other risk factors can contribute to WMSDs, such as age, gender, smoking, andprevious injuries

AGE: The older we grow in age, the longer the body takes to repair worn-out tissues andmuscles.

GENDER: As a result of hormonal differences between male and female genders, a womanturns to get easily affected with WMSDs.

SMOKING: Smoking reduces the amount of oxygen in the blood, thus smokers will turn toheal slowly when injured or involved in an accident.

PREVIOUS INJURY: A worker who had an injury before, is at high risk of being affected again, as the injured muscle might still be strained, as it might not have had enough rest orcompletely healed.

2.5 CHARACTERIZATION OF ERGONOMICS

Unlike major accidents caused by human or mechanical errors resulting in explosions that can affect both employees and the surrounding environment, Ergonomic accidents turn to affect just the employee carrying out a particular task, thus a greater focus is on the health of employees and not just the cost benefits of the company. The quantitative risk assessment method (QRA) has been the most frequently used assessment method for most petroleum industries offshore for the risk assessment of major accidents. This is an assessment methodthat has to do with the evaluation of risk and analysis of risk, and it is often also referred to as the Probabilistic risk assessment method because it identifies, analyses, and evaluates risk (Willy Roed. Vol 1). However, the ergonomic risk assessment methods, which will be more explained in the further chapters, are methods that use more of a coding system and a characterization action table to identify the postures that may threaten the health of personnel. These characterizations are the guides for decision-making. Note should be taken that, unlike major accidents where experts rely on background knowledge to help analyze an identified risk to get a probability of an expected outcome, ergonomic assessment methods are based on observations, questionnaires, and stationed cameras to identify the work postures personnel find uncomfortable that acts as a threat to their health. This concept uses more of the observational method by taking photos or installing static camerasin workstations to get data for its analysis. Thus, no need for an expert to carry the analysis.

Ergonomic deficiency could be as a result of inadequate training, poor relationships between managers and workers which can lead to psychological trauma, lack of training done to master machines and safety rules, inadequate skills, and limited resources to easethe work task. Ergonomic hazards can result in poor health conditions like back pain, body aches, fatigue, stress, and uncomfortable working postures. Poor human-machine system designs, inappropriate management, a mismatch between workers' ability and job demands, and ill-structured jobs can be the major cause of the injuries and disabilities encountered in this industry (Ashraf A.Shikdar & Naseem M.Sawaqed; 2004). Injuries resulting from ergonomics most often affect employees who are exposed to the lifting of loads, painting, working on gratings, working on heights, manual handling, confined space, electrical exposure, rigging, exposure to pressure, and stored energy, mixing/handling chemicals, welding, etc. Exposure to ergonomic factors will expose employees to high healthrisks as a result of injuries such as Back strain, burns, crushing/trapping, drowning, falling, shock/electrical, slipping/tripping, suffocating, skin irritation, high noise/vibration, cuts, fire/explosions/ignition, etc (Biman Das and Arijit K.Sengupta, vol 27;1996).

2.6 ERGONOMIC ASSESSMENT TOOLS

An ergonomic assessment helps in giving a little clear anticipation and correction actions toimprove workers working conditions and reduction of occupational accidents.

An analysis of the physical workplace risk factors can be grouped into four categories:

-Checklist

-Interactive form based

-Observational

-Direct measurement

None of these assessment tools can be considered the perfect assessment tool to be used, but each of them can be helpful for an ergonomist in the field to carry out a risk assessment(Marras & Karwowsk, 2006), and each of these assessment tools have their pros and cons

Checklist: this tool does not require any form of special equipment to gather materials needed for the assessment, but with such a method, the reports can easily be misused, andthe observer can be biased in his evaluation.

Interactive form: With this use of this tool, a large population can be sampled to get materials and a better understanding of workers' worries is understood due to the one-on-one interaction with the observer. But this method can also be very costly, and the responder can be biased in his report.

Observational: This seems to be the most flexible method for the observer, but his report cannot be fully trusted because it can be bias and his presence on the workstation can affectthe worker's actions then.

Direct Measurement: This tool seems to be the most reliable to be used amongst the othertools to trust its results. However, it can also be very costly to get the equipment and the equipment can also alter work conditions then.

Several risk assessment methods have been used to identify poor work postures resulting in ergonomic injuries in this industry. On a general note, these methods derive their information based on observational tools and stationed cameras. The next chapter gives a brief explanation of the REBA and RULA assessment methods. These two methods focus onthe upper and lower limbs respectively. However, this thesis focuses on the OWAS method because it does an assessment that includes both the upper and lower limbs (Back, Arms, Legs, Weight), putting into consideration complaints regarding all body parts, made by personnel.

CHAPTER THREE: ERGONOMIC RISK ASSESSMENT METHODS

Due to the increased rate of Manual material handling (MMH) in most industries, there has been a concern on the risk personnel are exposed to, which has led to an increase grate ofmusculoskeletal disorders(MSD) in the workplace. In the past years, many risk assessment methods have been used to identify the poor work postures employees practice which results in MSD. Some of these assessment methods have been REBA, RULA, and Ovako systems.

3.1 RAPID UPPER LIMB ASSESSMENT(RULA)

RULA is an assessment method for musculoskeletal disorders which focuses on the upperlimbs of the body. It was introduced in the year 1993 by McAtamney & Corlett(Tanuja

Jukariya et al & Dr. Suman Singh, 2018). This method is based on surveys with the use of employee assessment worksheets to evaluate the ergonomic risk associated with Musculoskeletal disorders in a work environment and this method evaluates risk factors related to postures, movements, work duration, Repetition, and force which affects severalbody parts like the lower arms, upper arms, neck, Trunk, wrist, and legs(Kian Sek Tee & Eugene Low, 2017).

This method evaluates postures affecting the human body by dividing it into two segments,which are **Group A** and **Group B.** Group A evaluates postures affecting the arm, forearm, andwrist, while Group B evaluates postures affecting the Neck, trunk, and legs.

Each of these body parts in these groups has a table of classification to describe its criteriaas seen below, and a mean score is derived from a classification table, which is used to determine the action category for the posture.

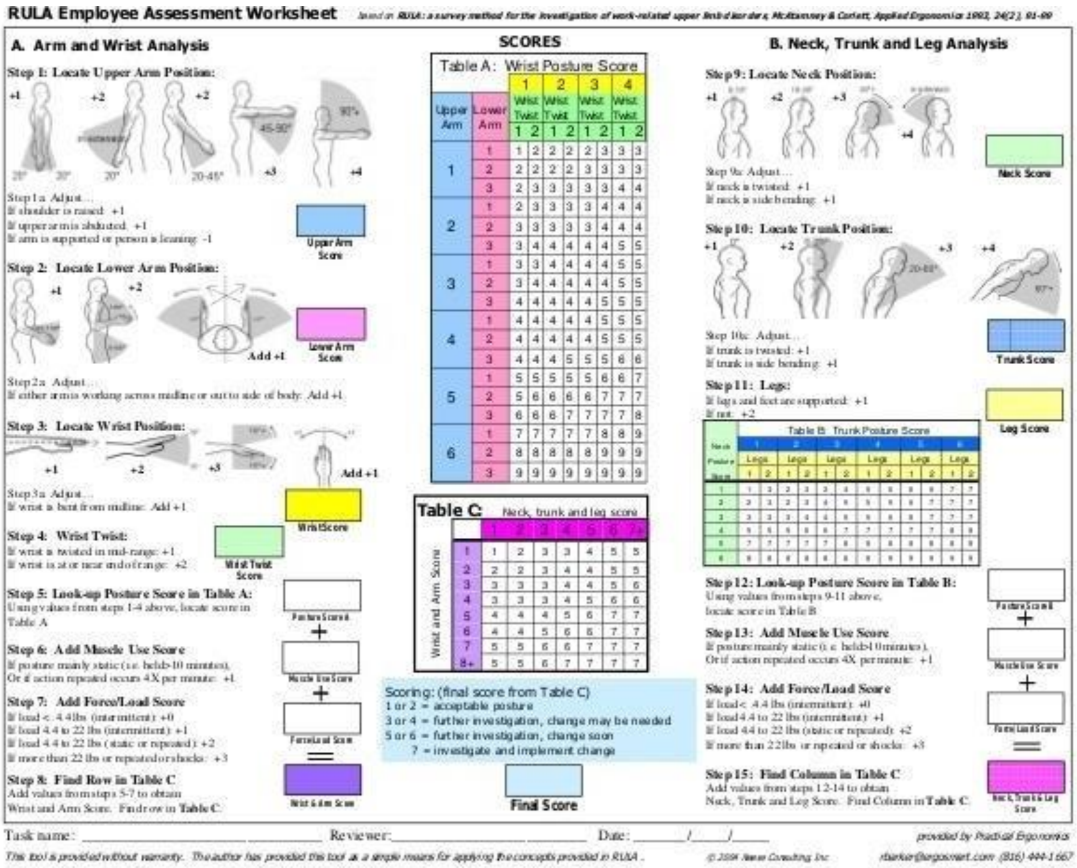


Fig.6 RULA Employee Assessment Worksheet (McAtamney & Corlett, Applied Ergonomics,1993)

Massaccesi et al(2003) make us understand this method brings out the exact values toexplain the effects of load on the Neck and trunk as against the perception of individuals. Thus claiming is a reliable tool for Rapid load assessments.

3.2 Rapid Entire Body Assessment (REBA)

Rapid entire body assessment (REBA), is a postural analysis tool that was developed to analyze musculoskeletal risks in a range of tasks related to load handling(Hignett, 1998). Unlike Rula that focuses on Upper limb assessment, REBA is a screening tool for theentire body to assess postural loads. This method is derived from the RULA and OWAS assessment methods but it entails just the Group A part of the RULA assessmentmethod(Arms, forearms, and wrist).

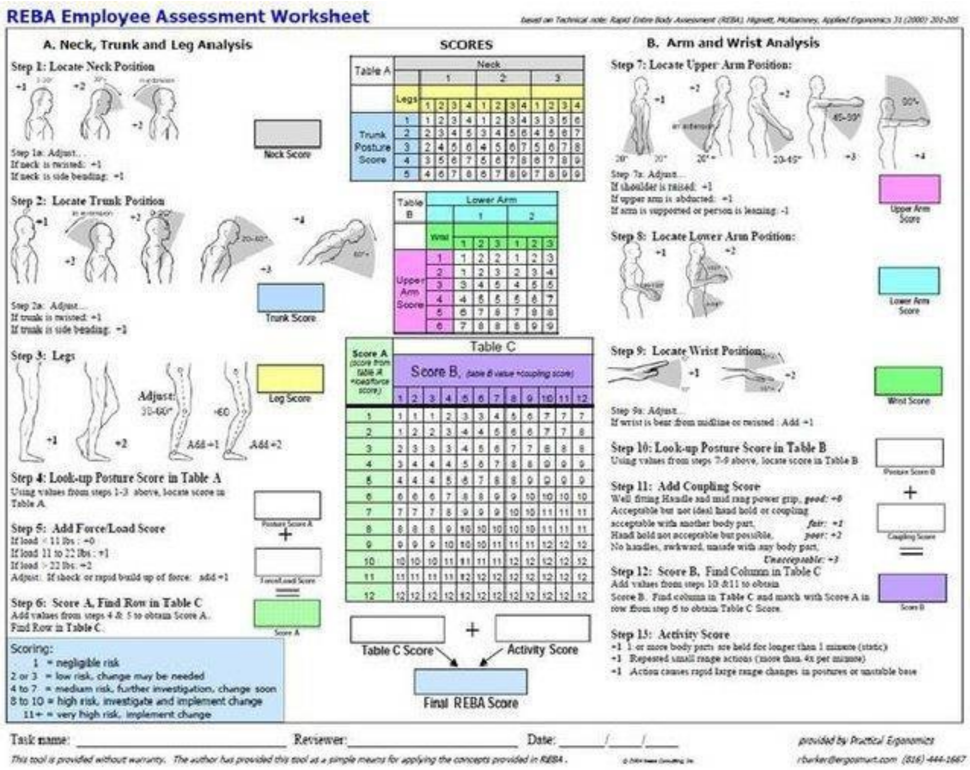


Fig.7 *REBA Employee Assessment Worksheet (McAtamney & Corlett, Applied Ergonomics,1993)*

A mean score is also calculated using the classification table, but instead of a four actioncategory like the other assessment methods, REBA uses a 5 action category table for decision making, whereby, Zero (0) indicates a good handling posture, while 3 indicates anunacceptable handle postures.

3.3 OVAKO WORK POSTURE ANALYSIS(OWAS)

Ovako work posture analysis is a method used in identifying and evaluating risky work postures in the working environment. This method aims to figure out the poor work postures that affect the back, arms, legs and estimate load weights workers are exposed to(Karhu,1997). This is to improve the work condition of workers.

The implementation of OWAS started in a Finnish company called OVAKO OY by Karhu andhis friends, in an institution of occupational health. This institution carried out studies on work behaviors that affect the neck, legs, arms, and shoulder (Karhu,1997).

The OWAS method makes reports based on observation through photography (Muybridge,1887) and provides results in the form of categories of work postures that leadsto MSD. These attitudes are encoded into four sections; the arms, legs, back, and load weight and each of these sections is being classified in its way. Several postures are observed when carrying out an analysis for each of these four groupings (arms, legs, back, and load weight).

The back is observed and evaluated based on postures related to bending, standing, bending sideways or bending forward.

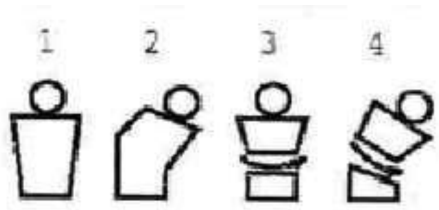


Fig.8 Work postures related to the back (Medan,2018)

The arms are evaluated based on postures where both arms are under the shoulder, onearm above the shoulder, and both arms above the shoulder.

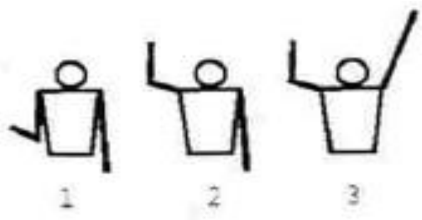


Fig.9.Work postures related to the arms (Medan,2018)

The legs are evaluated based on postures involving, standing on both legs straight, standingon one straight leg, sitting, standing or squatting with both knees bent, standing or squatting with one knee bent, kneeling on one or both knees, walking or moving.

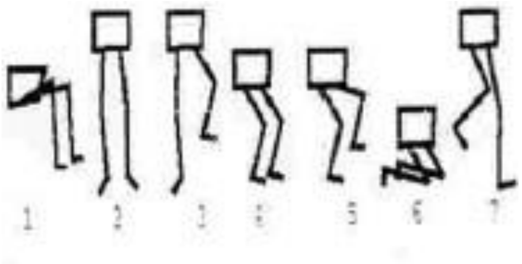


Fig.10. Work postures related to the legs (Medan,2018)

Load weights are evaluated according to the weight, i.e. weight less than 10kg, weightbetween 10kg-20 kg, and weight greater than 20kg.

This classification is based on subjective discomfort and health effect for each posture.

The diagram below represents the classification of OWAS concerning some possible workpostures in an industry.

The OWAS method uses 252 postures (4 x 3x 7 x 3), and load combinations. This is a combination of 4 back postures, 3 arm postures, 7 leg postures, and 3 load weight and the analyst has the responsibility to generate the codes for each of these postures (Shivani Chowdhury Slian,2012)

A code of four digits is given for each posture identified. An example is illustrated in thefigure below, in which the employees' work posture can be described with code 2243 by using the OWAS system.

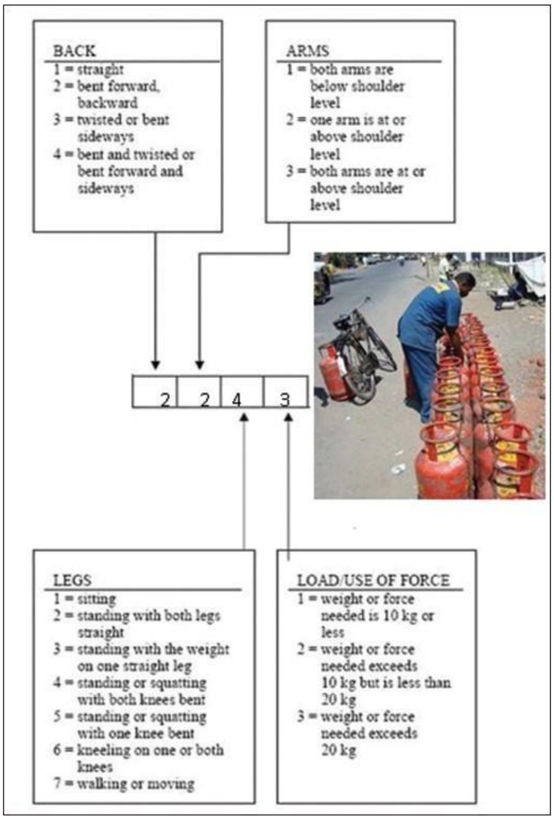


Fig.11 Ovako work assessment system technique (Medan,2018)

Source: International Journal of occupational and environmental medicine,2012

A four-point rating scale is then used to identify the amount of discomfort for each of thesework postures. The four-point rating scale has two extremes; A normal posture with no discomfort and effect on health, and an extremely bad posture or short exposures which may lead to discomfort.

A mean rating is then calculated for each of the postures and a ranking is established, whichclassifies the ratings into four categories:

Category 1: Normal postures which do not need any special attention

Category 2: Postures indicates a significant dangerous threat and will need attention duringthe next regular check

Category 3: Postures in this category indicate threats that need immediate attention andaction.

Category 4: Posture indicates high risk and will need immediate actions to prevent MSD.

This method has led to an improvement in comfort for most workers in companies as a result of the reconstruction done on work posture for employees. This method is quite easy to use as an observation on postures can be easily recorded.

The first stage of this method involves ranking each posture based on codes which will bedone by using the OWAS technique for grading as represented in the table below.

Body parts	OWAS code	Description of position
Back	1	Back straight
	2	Back bent
	3	Back Twisted
	4	Back bent and twisted
Arm	1	Both arms below shoulder level
	2	One arm at or above shoulder level
	3	Both arms at or above shoulder level
Leg	I	Sitting
	2	Standing on both straight legs
	3	Standing on one straight legs
	4	Standing or squatting on both feet, knees bent
	5	Standing or squatting on one foot, knee bent
	6	Kneeling on one or both knee
	7	Walking or moving
Load Handle	I	Load$<$10kg
	2	10 $<$ Load $<$ 20kg
	3	Load $>$20kg

OWAS: Ovako work assessment system

Table 1 : Definition of posture codes

Source: International Journal of occupational and environmental medicine,2012

Based on the coding derived from the above table, an action category based on a classifiedposture combination is derived.

Back	Arms	1			2			3			4			5			6			7			Legs
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	Load Handled
1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	1	1	1	1	1	1	
	2	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	1	1	1	1	1	1	
	3	1	1	1	1	1	1	1	1	1	2	2	3	2	2	3	1	1	1	1	1	2	
2	1	2	2	3	2	2	3	2	2	3	3	3	3	3	3	3	2	2	2	2	3	3	
	2	2	2	3	2	2	3	2	3	3	3	4	4	3	4	4	3	3	4	2	3	4	
	3	3	3	4	2	2	3	3	3	3	3	4	4	4	4	4	4	4	4	2	3	4	
3	1	1	1	1	1	1	1	1	1	2	3	3	3	4	4	4	1	1	1	1	1	1	
	2	2	2	3	1	1	1	1	1	2	4	4	4	4	4	4	3	3	3	1	1	1	
	3	2	2	3	1	1	1	2	3	3	4	4	4	4	4	4	4	4	4	1	1	1	
4	1	2	3	3	2	2	3	2	2	3	4	4	4	4	4	4	4	4	4	2	3	4	
	2	3	3	4	2	3	4	3	3	4	4	4	4	4	4	4	4	4	4	2	3	4	
	3	4	4	4	2	3	4	3	3	4	4	4	4	4	4	4	4	4	4	2	3	4	

Table.2 Action categories for each Ovako work assessment system classified posture combination

Source: International Journal of occupational and environmental medicine,2012

Afterward, an evaluation is done for the posture combinations and an action categorify for prevention and recommendations is implemented, which is divided into four parts. The action category explains what the risk identified in the classification table represents.

Action category	Explanation
1	Normal and natural postures with no harmful effect on the musculoskeletal system – No action required
2	Posture with some harmful effect on the musculoskeletal system – Corrective actions required in the near future
3	Postures have a harmful effect on the musculoskeletal system – Correction actions should be done as soon as possible
4	The load caused by these postures has a very harmful effect on the musculoskeletal system – Corrective actions for improvement required immediately

Resource: (Karwowski and Marras, 2003)

Table.3. The action category for each Ovako work assessment system classified posture combination

The three above-mentioned assessment methods have been the most common assessmentmethods researchers use for ergonomic studies (Kian Sek Tee & Eugene Low, 2017).

However, because the RULA and REBA methods focus more on upper or lower limbs, making the assessment limited as it does not cover the entire body, this thesis focused moreon the OWAS method because it covers postures that affect the entire body (back, arms, legs, and weight). With this, the analyst will not be limited. This does not mean the OWASassessment method has no lacks. it is in this regard that the example presented below will show an illustration of how the OWAS method can be used for ergonomic risk assessment in the mentioned company and we will look at what recommendations can be suggested for this method in the chapter ahead.

3.4 Example: IDENTIFICATION OF POOR WORKPOSTURE USING OWAS AT HALLIBURTON AS

Halliburton AS, an intentional company in Norway, with one of its branches located in Stavanger that has about 1,750employees, is a company that aims at promoting and supporting activities for mining industries such as oil and gas extractions. In April 2016
"Black Day", this company experienced a drastic incident. On this day, a helicopter meant totransport 13 employees from Statoil's Gullfaks B platform to Fresland airport had a crash which led to a loss of 4 lives, and those injured were rushed to Bergen for medical attendance (Energy Voice,2016).

However, since the occurrence of that unfortunate incident, this company has put in its verybest to avoid the occurrence of such a deadly accident. This does not mean employees in this industry have been perfectly safe and free from harm. Though there hasn't been a record of any major accident since the last one, there have been records of occupational injuries because of poor work postures.

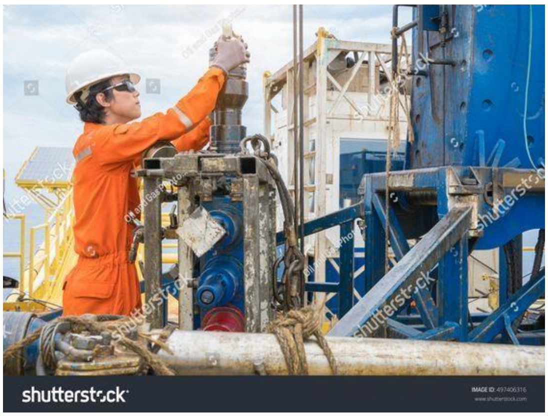
In gathering information on work postures this industry practices, a checklist was given to 10 personnel in the fields of mechanical engineering, progress engineering, rig workers, and simulation specialists. This was intended to assess the extent of MSD harm that personnel is perceived to encounter when exposed to certain work postures.

Mechanical Engineer

p.1

Progress Engineer

p.2



Rig worker *Simulation specialist*

p.3 *p.4*

Fig.12 Images gotten online used during safety training meeting for the industry uploaded on 07/10/21

The above images were taken online which show the most common work postures personnel practice in the petroleum industry. These images happen to be used as well during HSE training in this industry to educate personnel. Workers were asked to fill a checklist to identify work postures affecting the back, legs, arms, and amount of load theycarry when performing a task. This checklist was based on a three-point scale with the following values:

Low frequency

Medium frequency

High frequency

With the use of his checklist, it was easier to know how workers perceive their working conditions, as several of them complained of MSD disorders and the pains they have beenexperiencing.

3.5 RESULT ON POSTURAL ANALYSIS

Based on the postures presented in the figures above, it was easy to figure out which postures pursed as a threat. from the OWAS coding P1 was coded as 2,1,7,1(2=back bent,1=both arms below shoulder level,4=standing on both feet, knees bent,1=load<10kg), P2 was coded as 2,1,6.1(2=back bent,1=both arms below shoulder level,6=kneeling on bothknees,1=load<10kg), P3 was coded as 1,3,2,1(1=back straight,3=both arms at or above shoulder level,2=standing on both straight legs,1=load<10kg), P4 was coded as 1,3,1,1(1=back straight, both arms at or above shoulder level,1=sitting,1=load<10kg).

JOB DESCRIPTION	CODED BASED PERFOMANCE	CARTEGORY CLASSIFICATION
Posture 1	2,1,4,1	2
Posture 2	2,1,6,1	3
Posture 3	1,3,2,1	1
Posture 4	1,3,1,1	1

Tab.4. Action category table

Based on the action category the various work postures can be evaluated as;

Posture 1 indicates a harmful posture that will require intervention in the future but is not a necessity to capitalize on now.

Posture 2 indicates a threat to the musculoskeletal system that will require immediateaction to prevent further risk

Postures 3 and 4 are both postures that do not indicate any threat as of now to themuscles and can be maintained except proven otherwise.

From the above analysis, the result of the study shows that postures that require the workerto bend their backs forward and kneeling or squatting on one or both legs will in a long run serve as a threat to their musculoskeletal system, especially if exposed to this posture over along period, and a greater effect will be on the back, neck, and trunks, though this assessment method does not put into consideration postures that affect the neck and trunk.

When trying to understand why we have these ratings, it can be observed that P1 could bemodified to improve the working posture. Most of the people who filled the checklist complained of back pain and we can see how this MSD is derived from P1. A recommendation for this posture will be the provision of a work surface equal to shoulder level, that will prevent workers from bending often. this posture will not only affect the back but the neck as well in a long run. A reduction of time duration spent on this posturecould reduce the after-effects as well.

However, P2 with code 2,1,6,1 was identified as the posture requiring immediate action because of the pain caused on the knees, neck, and legs. This posture is mostly practiced byprogress engineers when taking records or some mechanical engineers at the work stations. The pain inflicted on both legs as a result of kneeling on one leg, and bending the other leg, could be reduced if the person could bend on both knees and sit on them, depending on if he must go low to take a record or perform a task.

P3 could also purse as a threat in the long run as personnel continues to work with hands above shoulder level. This could be avoided by him standing on a high surface(stull), whichcould make his height almost the same level as what he is working On

P4 seems to be the most comfortable work posture practiced with little or no negative MSDthreat on personnel.

Generally, it was observed personnel are not exposed to much load while working. Theobjects used to carry most of their tasks were noted to weigh less than 10kg. This can beseen in the four postures used above for the analysis.

CHAPTER FOUR: DISCUSSION AND RECOMMENDATIONS FOR OWAS

In this part of the thesis, the first section will discuss the theoretical framework in line with the example presented above in chapter 4, where the OWAS method was used for ergonomicrisk assessment, and further in the chapter recommendations to improve the OWAS method will be suggested.

From the above example, risk identification is carried out through the collection of data gotten from stationed cameras and through interviews and a checklist. Cameras are planted in workstations to capture activities and postures of employees while at work and a checklist was given to 4 workers carrying out the different tasks (mechanical engineer, rig worker, progress engineer, and simulation specialist), where the risk postures were identified. This process does not need an expert to carry out the risk identification like in major accidents, but it seems vague as the cameras are planted at the workstations, and maybe impossible to take all work postures especially if the worker must move his spot.

Also, the risk analysis method used is a coded form analysis method where postures are described using codes., whereby postures that affect the back, arms, legs, and amount of load weight injected on workers are classified into different categories which are then coded. These codes are then used in describing the identified work posture. The mean codeis done by using a computerized system to give a more accurate result. This system also helps in reducing human labor and saves time. However, this method of risk analysis does not put into consideration other aspects that can contribute to MSDs in employees such as age, duration, and sex. The amount of time spent in carrying a task must be considered as well. This will help managers in decision-making to determine if lesser hours should be givenfor a task to be completed or work should be done in shifts to avoid fatigue, stress, and MSDs.

Again, from the risk evaluation carried out, it was noted that posture 2, with codes (2,1,6,1),had an action category of 3, which indicates immediate action should be carried out as the posture poses as a threat that can cause an MSD based on the action category table. The risk evaluation process is meant to direct the managers in decision making and, in this case,
, immediate action is required.

From the checklist and interviews on a few of the workers in this company, it was discovered the degree of communication between employees/managers or employees/employees at different levels was not the best. Sometimes, workers have in possession of the facilities to carry out a task but do not communicate amongst each other to ease the work. One person may not be able to identify an error and another person could and share the ideas. Most managers focus more on financial benefits, while workers focus more on their health and safety, hence there is a conflict of interest. Some employees think the middle managers are not fully involved in safety maintenance except for the production unit, as their focus is cash flow, and they turn not to notice how stressed the workers can bedue to the work pressure trying to balance work demand which could affect productivity.

Also, some employees feel there are so many procedures and rules to be followed, and theyturn not to be able to study all and end up making errors that can put them in a risky situation. However, some said these procedures do not allow them to think out of the" box'' incritical situations trying to solve a problem.

Also, employees find themselves in accidents because of failure in using the right protectivesafety attires or using the right equipment. This often happens when workers try to get work done fast by using a shortcut, and not the normal procedures, they might end up causing an accident or incurring an injury if care is not taken.

The OWAS method which focuses on the use of stationed cameras to identify work posturesfor the analysis process might not be able to identify the threats workers phase when exposed to some work postures. The chairs and tables workers use in carrying a task influences their health.it gets to determine if workers must stretch their hands above shoulder level for a long time, must kneel, or need to stand before a task can be completed. These are postures that if practiced over a long duration, will lead to a musculoskeletal disorder in a long run. Thus, these are areas where risk identification must be taken into consideration to implement barrier-reducing measures. Also, it was noted that most of theworkers focus on a particular task and barely multitask. Repeating the same task over and overmight not only become tiring but boring for the employee. Employees could find their job more interesting if they can do other task order than the usuals., then they turn to gain more skills, and this is also advantageous to the company, so they never lack a replacement in the absence of one employee. This method does not determine the probability of certain postures to pores as a threat tothe MSD system, and this is because the module carries out an identification analysis through observations and static cameras but does not carry out a cause analysis to know what will make workers prefer taking a particular posture in working. If the cause can be identified, then it makes it easier to know what remedy could be implemented to reduce the health risk personnel are exposed to when performing a particular task.

Also, this module focuses on the health of personnel and does not consider the effect a wrong posture practiced by personnel can have on the assets of the company. The action category is based on the decisions related to the postures alone, without considering the effects absent personnel can have on company productivity. Thus, it is recommended that inas much as concern is laid on the personnel, a proper risk assessment should be made to ensure these postures won't affect company assets in a long run as a result of an employee on sick leave.

The OWAS method is a static assessment method that follows a particular format to carry out its analysis. The accuracy of this method is quite unreliable because it does not elastic and open for other views. An elastic method can give room for robustness and the chance to consider other views for the subject. This module does not bring out barrier methods to avoid consequences but rather focuses more on the after-effect of the existing wrong postures. Thus, a more elastic approach that can discuss the barriers of MSD risk could be abetter assessment method.

Also, this method uses data collected either through observation or stationary cameras. The implementation of image analysis for recording could give better statistics as it will provide more samples to be evaluated. With the use of computer techniques, it makes it easier to get a larger number of digitized images for accurate analysis. In cases where the analysis entails postures for more than one workstation, the analyst will have to be mobile because a record from a stationary camera can't possibly pick out all angles in the workstations.

This method is meant to identify dangerous work postures where workers are mobile, thus the analysis must be presented in a way that includes both mobile workers and stationed cameras.

Data collected through a stationary camera does not indicate the duration of time spent on the identified work posture, thus making the analysis vague because for a posture to be considered risky, the duration spent on that task must be considered to know if an improvement method could be on reducing the time spent on a particular task and might need a rotation of shifts or more break periods for the worker.

CHAPTER FIVE: CONCLUSION

The concept of occupational safety comes into place because though major accidents have been the most fatal accidents that have occurred in the Norwegian petroleum sector due to its effects on both employees which have led to a few dead and injured cases and effects on the surrounding environment as a result of gas leakage or explosions, Personnel has been experiencing workplace injuries as a result of wrong working postures practiced, which has affected their health with frequent complains of pains on the back, legs, and arms .that is why this thesis focused on the ergonomic risk assessment methods used in identifying postures that threaten the health of personnel.

To answer thesis question one regarding the characterization of ergonomics as too other accidents like major accidents, we realize ergonomic focuses more on occupational health and its consequence of occurrence will be limited to only the personnel, unlike major accidents whose consequence upon occurrence will not only affect the personnel, but also the environment and company at large. The probability of occurrence and the uncertainty of the consequence is based on background knowledge and experience from employees who may have incurred injuries because of the practice of common work postures and because its assessment methods do not give a broader view of risk identification, it becomes difficult to give a realistic decision regarding work postures practices.

In respect to thesis question, 2 which was meant to explain the ergonomic risk assessment techniques RULA, REBA and with focus on the OWAS which was explained with an example, we can realize the OWAS, together with RULS and REBA have a common assessment process which involves the coding of work postures and ranking base on the OWAS characterization table, meant to be used for decision making. Firstly for the fact that risk identification is done through stationed cameras and background knowledge based on past experiences from workers, the evaluation will seem vague because the probability of occurrence can not be determined through observations carried out by anyone since it does not necessarily need an expert to carry out the assessment. Information gotten from personnel might not be completely reliable and it can be biased either by the interviewer or the personnel being questioned. This method does not put into consideration the duration of time spent on a particular that can lead to health problems. thus it can be concluded that the results from this method can not be reliable enough for decision making to bring out the barrier to prevent occupational injuries.

We will therefore say the ergonomic risk assessment methods, especially the OWAS since 7it covers general body parts which can be affected by poor work postures, needs to be greatly improved on. The risk identification method should not only be based on observations and checklist, but an expert should be able to determine a real probabilistic model to bring out the postures that could provoke occupational injuries, this way consequence barrier measures can be identified which will give the evaluation better results for decision making.

Conclusively, we will say the Ovako work assessment technique cannot be considered the best method for ergonomic risk assessments. The hazard identification process through observations and stationed cameras is limited and a vague way to get troublesome work postures personnel are exposed to and the characterization tables being used does not validate the decision making regarding the identified posturesThere has to be a change on how the risk of wrong postures is being identified to be able to figure out the barriers to reduce or prevent occupational accidents leading to ergonomic injuries.

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