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Alotaibi, Abdulaziz *An Analysis of Risk in Petrochemical Company*

Abstract

The chief objective of this study was to evaluate the purpose of ergonomic central beliefs to the standard tasks performed by the personnel at Company XYZ. Goals were developed to achieve the objective of this study. Quantitative assessment of the work was conducted to determine the extent of the problem. Qualitative perception surveys were conducted to ascertain the magnitude of the problem. The evaluation consisted of ergonomic assessments, surveys, and a workstation design analysis to identify any risks connected with the tasks at Company XYZ.

The types of ergonomic risk factors that were found in the random upper limb assessment and casual entire body assessment processes were repetitive wrist movements, pinch grips, and awkward postures. Interviews with the workers and management were conducted to identify their opinions on the causes of ergonomic risks and what they thought could be done to improve workers' safety and eliminate risks associatedwith rotating large valves. The researcher identified some possible controls and procedural changes to improve the three current random upper limb assesments and random entire body assessment process to reduce or eliminate the risk of ergonomic injuries. Recommendations and conclusions were made on how to reduce or remove these ergonomic hazards.

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Chapter I: Introduction

The Middle East is known for the high amount of crude oil that is frequently exported from the region. As such, many companies have been set up in the area to specialize in the process of manufacturing the various by-products obtained from the crude oil. These are known as the petrochemical industries. XYZ Company specializes in the production of synthetic rubber and to a lesser extent fertilizer for agricultural purposes. The company was formed in the year 2008 with the objective of satisfying the high demand for synthetic rubber in the market.

Company XYZ employs over 850 workers. All of the employees have been employed on a full-time basis, and they are tasked with operating some of the most advanced technologies within the industry. Employees who work within the refinery section are typically referred to as the "Refinery Unit Operators." Their primary tasks in this department involve the constant monitoring of the piping process and equipment. They take notes on the pressure of various systems, temperature, the connection of new filter systems, and operate the rotating valves. The task that is commonly considered to be heaviest involves opening and closing the rotating valves, which has the greatest potential for resulting in shoulder and spinal cord injuries. Additionally, this task has to be repeated over and over again since various units have to be shut down and re-started after different durations of time.

Statement of the Problem

In XYZ Company, the primary concern is to develop risk management measures so that the health of employees is not compromised since they play a crucial role in the production process. Likewise, such measures will help to ensure that, whenever any of the risk factors occur, the process of production will not be hampered. Apart from the above dangers that may arise in the course of operating large rotating valves, risk mitigation measures are adopted so as to ensure

that it is easy to compensate the workers' health benefits. XYZ has four distinct sections that need to be covered by a single employee for each shift. The major task that employees undertake during their shift is rotating large valves. It is typically done when the refinery units are being opened or closed. Some of the major valves that need to be rotated are the gate valves, plug valves, pump valves and those that regulate the flow of liquid between vessels.

There are more than 100 valves spread all across the company, and the employees are usually required to rotate not less than ten valves in a single day.The employees are therefore exposed to various ergonomic hazards as they rotate these valves, which impact negatively on their health due to the repetitiveness of the task.The health implications of rotating these valves and the manner in which it affects employees' ability to work efficiently are explored in this research.

Purpose of the Study

The main reason for undertaking this research was to understand the ways in which ergonomics hazards affect the workers at XYZ Company as they rotate valves at various sections of the company. The tasks that most employees in the company undertake can be physically demanding. This research also examines the different measures that management undertakes to address the ergonomics issues within the company. There are periods during which the company is not operational, and this happens toward the end of the year as major repairs to all facilities within the company are carried out. However, at the beginning of the year, continuous production is performed to cover for the months when the facility is closed down. Therefore, the research was undertaken in the month of February 2017 as the researcher was sure that it would be possible to get all facility workers and the managerial team within the facility conducting their day-to-day activities.

XYZ employees have to perform their duties on a daily basis, and some of these are repetitive, which can lead to the development of health problems. Therefore, the company employees are the primary target respondents of this research. The research is based on the activities carried out by the workers during the process of rotating large valves at various sections of the companies. The research is undertaken entirely within the XYZ premises as it targets the workers who have been employed there.

Assumptions of the Study

Before undertaking the research, it was assumed that obtaining information from the managerial team would be a tough undertaking since, based on previous experiences, most people do not like disclosing information that would negatively affect the company's reputation.

Limitation of the Study

One important factor that limited this study was the lack of crucial information on the manner in which Company XYZ had managed to reduce injuries through ergonomics monitoring. Based on complaints from the employees, it was unclear the way in which the company intended to address the matter conclusively. Also, it was unclear if the company compensates its employees or if all employees have subscribed to a medical scheme which is covered by the corporation. The company is still in the process of growth, so a lot of the profits appeared to be directed to other undertakings that would enable the growth of the enterprise.

Methodology

This research relied on data obtained from various sources. The primary source of data was based on the researcher's previous experience working in a petrochemical industry and the various observations that were made while taking a tour of the company premises. The other main source of data was from conducting interviews with the managerial team in XYZ Company.

Based on the results of the interviews, further insight was gained into the matter since the company managers were lenient enough to explain the manner in which the production process of petrochemical products takes place within their businesses.

Summary

This chapter has therefore introduced the various factors that will be addressed in this paper on how ergonomics is being treated so as to ensure the proper health of employees. In Company XYZ there seems to be some compromise on the health of workers since some factors in the process of operation have not been considered. The methodology section has been used to describe the manner in which the data that is utilized in this research was collected.

Before undertaking this study, an assumption was made about XYZ Company, and it was outlined in the assumption section. Various limitations were, however, realized, which appeared to contradict the assumptions that had initially been made. In the next chapter, an in-depth literature review is undertaken on companies concerned with the production of petrochemicals. Various facts are examined and analyzed further based on how the issue of ergonomics was handled in the past by the management of the different companies that will be analyzed.

Chapter II: Literature Review

The design and structure of most workplaces are configured in a manner that can suitably support and accommodate the operation of machines so as to ensure efficiency in the production process. Less attention is directed towards the manner in which people can comfortably fit into and operate in the workplaces. The most common assumption made by company managers is human beings will automatically adapt. Hence, they are left to fit into the already laid out infrastructure without much concern about how it affects them in the long run. Workplaces are commonly associated with continuous, repetitive action, awkward postures, and the use of excess force when doing various tasks (Muggleton, 1999). These lead to the occurrence of injuries on different parts of the body being experienced by most individuals who work in industries where there is heavy machinery being used.

According to Hägg (2003), the human factor of production and ergonomics relate to each other in a major way since both terms are typically employed in the description of how a worker can interact with different equipment so as to successfully achieve certain tasks in the workplace. The term ergonomics is mostly used to refer to the manner in which the work being undertaken ends up affecting the workers' health. Human factors relate to the development of designs in the workplace that help to reduce potential human error in the workplace (Karwowski, 2001).

When various environmental and traditional risk factors in the workplace are adequately addressed, the workers end up being saved from the possibility of being affected by risk. Potential risk factors and the risks themselves are some of the common concepts that have frequently been applied to the literature of ergonomics (Salvendy, 2012). The term risk refers to the possibility, consequence, seriousness or the severity of something occurring. Therefore, risk analysis tends to

focus on the number of accidents that occur when workers are exposed to a particular factor (Keyserling, Stetson, Silverstein, & Brouwer, 1993).

In other cases, it is possible for a worker at a site not to get injured as he/she undertakes duties that have been assigned, which makes the premises appear to be safe. However, the fact that the worker is not injured does not imply that there is no existence of risk. Therefore, it brings us to our second term, risk factors, which indicate the existence of conditions or occurrence of actions that tend to increase the possibility of dangerous situations occurring. The risk itself is what will end up affecting the worker's musculoskeletal system negatively (Öztürk, 2011). The specific hazards that we are looking into are the ones that have cumulative effects on an employee's health. Such risks are known as cumulative trauma disorders (CTD) or, in other words, work associated musculoskeletal disorders (WMSD).

Common diseases associated with the repetitive tasks include:

- Tendonitis,
- Peritendonits,
- Carpal tunnel syndrome,
- Radial tunnel syndrome,
- Pronator teres syndrome and
- Ganglion cyst

Ergonomic risk factors that lead to the occurrence of the musculoskeletal disorder are forceful motions, vibration, awkward postures, mechanical stress and exposure to extreme temperature levels. Apart from these, some physical and psychosocial factors can also be included, and they frequently lead to the occurrence of strain. Such factors include emotional and

cognitive stress that is typically brought about by the existence of psychological factors such as social relationships, lighting, and indoor climate.

Certain organizational factors frequently result in the increase in the possibility of cumulative trauma disorder risk occurrence. They include long duration of work, lack of breaks between periods of work, insecurity of the workplace, and monotony in a particular job. It is important to note that, when more than one risk factor is in existence, then the possibility of CTD occurring increases.

Most of the epidemiological and ergonomic studies that have been previously conducted have focused on the relationship that exists between the various occupational risks and the occurrence of musculoskeletal muscle disorders on the shoulders, neck, and even on the arms. Additionally, the frequency of WMSD in the lower body parts is not as common as the rate at which musculoskeletal complications occur on the upper body section. Constrained postures that are usually adopted by workers in their working environment are what mostly lead to the occurrence of musculoskeletal disorders in Company XYZ (Drinkaus, 2003).

The existence of ergonomic risk factors due to rotating large valves is a condition that is either created intentionally or unintentionally, and it typically goes against the philosophy associated with ergonomics since it ends up affecting the ability of the employees to work efficiently (Zinchenko, 1998). Therefore, it is imperative for Company XYZ to understand the negative aspects that are associated with the occurrence of ergonomics risk factor within the organization. The most important thing is, therefore, to come up with suitable solutions that can adequately address the matter.

While all types of jobs have risks that are associated with them, the continuous and long-term exposure of employees to the risk factors that have been mentioned above can lead to a

reduction in their quality of life. Company XYZ should, therefore, strive to ensure that all workers are well informed about MSD and the factors that lead to the occurrence of complications associated with this disorder. Employees should be provided with the relevant skills and knowledge of how the various factors can easily be categorized so that they can understand how they can reduce the frequency and the length of exposure to such risks (Shuval, 2005). The ability to reduce exposure to various risk factors should ensure that a particular task is made smoother and that it is possible to predict outcomes in every occasion (Hess, 2004).

History of Ergonomics

Many scholars define ergonomics as the scientific study of how human beings interact with different elements of a system and the professionalism that is applied to data, methods, principles, and theories to maximize the output of human beings while performing a task. Therefore, ergonomics is a study that is associated with the manner in which devices and equipment are designed so that they can help in accommodating the movement of human beings within a facility in the most efficient manner.

The basic principles of ergonomics have been in existence since time immemorial. It all started when people began to create tools that would help them to simplify the manner in which they were able to perform various activities. As such, there was a need to ensure that when such equipment was handled, it would ensure that the performance of the task was made easier as much as possible (Gainer, 2008). Based on archeological evidence, it is evident that most of the people who lived in the past had developed their methods of doing things and they would continually look for ways to ensure that work was simplified. Most of the apparatuses that were used in the past appeared to follow some basic ergonomic principles so as to ensure comfort while

they were being used and to ensure maximum efficiency in the performance of tasks (Marras, 2006).

When World War II occurred, more of the principles associated with ergonomics started to be implemented in nearly all equipment that was being used at that time. Most designs that had been applied before the war were so complicated that it was hard to understand how to use the machinery. It led to a situation where using equipment became increasingly hard, and it created the need to ensure that efficiency was further improved. Most of the materials that were used before and during the war had to be redesigned so as to make sure that sensible placement of controls was achieved and that similar functions were put together so as to improve the ability to use them.

After World War II, the manner in which ergonomics was being employed in the design of different equipment and even within the workspace was altered. Nearly all technologies that were released into the market incorporated different aspects of ergonomics, which helped a lot in guaranteeing the human ability to provide maximum quality work using the least amount of effort when undertaking a task. The use of ergonomics had the greatest impact on the use of computers. Most functions that were performed by human beings started to be delegated to machines, and these gadgets found their way into most of the activities that people carried out. Computer usage required the repetition of tasks and therefore increased the level of strain (Dennerlein, 2006).

In modern ergonomics, various fields have been included, and they include those of occupational physicians, industrial engineering, and safety engineering. Another field of ergonomics is "cognitive ergonomics," which considers different factors such as perception of individuals to design and human behaviors. Almost all activities that people undertake have taken principles of ergonomics into account. Ranging from automobiles, office configuration, and

industries, efficiency has been maximized through improvement of user safety and comfort; life has become much easier than before.

Musculoskeletal Disorders (MSDs)

Workers at XYZ are at a high risk of developing MSDs because of the repetitive tasks of rotating large valves and operating other large machinery in the line of production.The leading cause of suffering among employees is an injury to the musculoskeletal system.This causes a loss of productivity, time, and substantial expenses because of worker compensation (Linton, 1990).

Most cases (63%) of MSD injuries occur from repetitive motion; 20% are from repetitive placing, grasping or moving of objects; 9% from typing; and 8% from repetitive use of tools (Salvendy, 2012). The causes of MSDs can be classified into two categories: the first may occur from a single event such as a strain or a sprain, and the second use may take place from numerous continuous events that gradually increase tissue damage from an accumulation of smaller injuries. Injuries develop over a period of weeks, months, or even years. The symptoms are rarely identified in early stages but become easily identifiable with progression, and the causes are not only restricted to the work environment but also at home and while performing recreational activities. The severity of MSDs may vary significantly among employees performing the task (Gainer, 2008).

Cumulative Trauma Disorders (CTDs)

In XYZ, hand and wrist traumas are the most common due to repetitive rotating of valves. In regards to a US Bureau of Labor Statistics report, of the 368,300 occupational disease cases in 1991, 233,600 cases were associated with repeated trauma (De Looze, 2003). The National Occupational Exposure Survey conducted by NIOSH from 1981 to 1983 anticipated that

4,034,474 workers in the U.S. potentially were exposed to chronic hand and wrist trauma (Urwin, 1998).

CTDs are a combination of musculoskeletal and nervous system disorders, which may be caused by repetitive tasks, improper posture, vibrations, forceful exertions, and compression on a sharp or hard surface. Regular workplace CTDs, such as carpal tunnel syndrome (CTS), tenosynovitis and tendinitis develop gradually over a period of weeks, months, or years (Bramson, 1998). CTS occurs with the compression of the median nerve by a sharp surface or a discomfited shaped object, which passes the carpal tunnel in the wrist. It can also occur because of swollen tendons in the carpal tunnel area.

Combination of high force exertion, high repetition, awkward posture, assembly work or packaging while working leaves a person at high risk of CTS. Complications of CTS are a loss of grip strength, increased pain during the night, and even the permanent loss of hand function. Tenosynovitis, in general, is a term for irritation of the synovial sheath of the tendon caused by CTD risk factors. When the sheath is irritated, increased amounts of synovial fluid are created, which accumulates and causes the sheath to inflate, leading to pain. Ineffective workstation design, tool design, and work culture may play a part in the development of this disease. CTDs may occur outside the work environment from activities involving repetitive motion or sustained awkward posture. It's hard to determine the cause of a CTD in a person who is suffering from diverse symptoms which may occur (Bramson, 1998).

Tasks in need of high rates of repetitive motion require greater muscle use than less repetitive tasks. The CTD risk is also augmented by the worker adopting awkward postures because of technical designs put in place to achieve work economy and simplification. CTDs associated with challenging positions include tenosynovitis of the flexor and extensor muscles of

the forearm and arise from full flexion and extension of the wrist. Non-occupational factors associated with CTDs include body size, strength, previous injuries, and joint alignment. Highly repetitive work combined with uncomfortable postures increases the risk of developing CTDs.

The suggested way of reducing the risk involves redesigning the tools and tasks to lessen biomechanical and repetitive musculoskeltal stresses (Torgler, 2005). Assessment of CTDs is based on self-reports of symptoms and pain as well as physical examination by a doctor. Doctors rely on medical history, leisure and occupational hazards, intensity of pain, a physical exam to locate the foundation of the pain, and every now and then lab tests, x-rays, or an MRI Doctors look for precise criteria to diagnose each diverse musculoskeletal disorder, based on location, type, and strength of pain, as well as what kind of restricted or painful movement a patient is experiencing. A traditional measure of CTDs is the Nordic Questionnaire that has a picture of the body with various areas labeled and asks the person to indicate in which areas they have experienced pain and in which areas the pain has interfered with usual activity.

Objectives of Ergonomics

The benefits of ergonomics can appear in many different forms, in productivity and quality, in safety and health, in reliability, in job satisfaction, and in personal development. The objectives of the study of ergonomics are to optimize the integration of man and machine to improve work rate and accuracy.

Ergonomic Control Measures

XYZ should use ergonomic control steps to ensure that the proposed changes to the worksites, the tools utilized by the workers, and the work surroundings in general, are properly integrated and producing the desired effect.

"Ergonomic controls provide intervention in three primary areas: work practice, administrative, and engineering" (Linton, 1990, p. 42). The use of these interventions is to pinpoint possible risk factors, look at their severity, prioritize them by their harshness, and finally use the knowledge obtained to settle on the most efficient method of reducing and correcting the risk factors. "This experience may affect complex technical systems or work tasks, tools, and workstations, or the tools and utensils used in the workplace, at home, or throughout leisure times" (Vandergrift, 2012, p. 30). Two types of controls are used to ensure that the planned ergonomic changes are producing the wanted effect: administrative controls and engineering controls.

Prevention of Accidents

The primary purpose of ergonomics is to ensure that all tasks that human beings carry out are productive and that efficiency while undertaking the various tasks is highly improved. Ergonomics' main aim is to ensure that all areas of work are efficiently streamlined so as to make sure that maximum output is achieved in the most efficient manner.

Ergonomics (or human factors) is the scientific discipline concerned with the understanding of interactions among humans and other basics of a system. As a career, ergonomics applies theory, principles, data and method to design and to optimize human well-being and system performance. As a field of study, it encompasses various areas of life that are associated with the application of physical and mechanical force. The different areas that are typically covered by ergonomics are:

- Human Engineering
- Anthropometry
- Occupational Biomechanics

- Work Physiology.

Various activities that can be undertaken to ensure that the complications associated with musculoskeletal disorders are completely avoided are:

- Use of pulleys and levers
- Rotating workers to avoid repetition of the same activity for long.

Muscle injuries commonly result from the repetition of tasks over and over again. In the course of undertaking work within the premises of our jobs, we frequently end up flexing, stretching elbows and adopting awkward positions so as to achieve tasks quickly. It is most common in situations where the tasks that are being undertaken are of a mechanical nature, such as in the process of rotating valves. When such actions are repeated on a daily basis, they automatically become potentially injurious. It is possible that the effects of continually repeating these tasks remain hidden for many years. However, when the disorder starts to present itself, it becomes impossible to undertake various tasks that one used to carry out. Therefore, playing smart is the key to ensuring that such injuries are avoided as much as possible.

At this point, it is clear that continuously repeating an action, using excessive force, and doing an activity repeatedly over and over again exposes one to injury (David, 2005). It is crucial to ensure all workers are clearly briefed and are familiar with the manner in which they should undertake various tasks and also the tools that they need to use within the industry. As a worker, one should choose to turn sizable valves that don't lead to excessive use of force. In case a task is too hard/cumbersome to undertake alone, it would be wise to request a colleague for assistance. Also, in the process of turning valves, one should adopt the most suitable position that will ensure no extreme postures are selected. Pitching positions should be entirely avoided by maintaining a low level of the wrist.

Other factors that are considered while turning valves would be to ensure that the elbow is kept as close as possible to the body while turning the valves and also ensuring that the environment of work is most suitable. In addition, it is significant to take occasional rests and apply ice to regions where one starts to feel pain. Additionally, it is important for a worker to stretch the body sufficiently so that the body does not adapt to one position.

Administrative Control of Ergonomics

Based on the principles of ergonomics, the administration of any enterprise has its obligation towards the well-being of the employees, and it should carry the burden of ensuring that the working conditions surrounding each worker within the company are safe and favorable. It is known as the administrative control of ergonomics. The various activities that should be undertaken by the administration are: provide a safe and secure working environment that encourages employees to work and hence provide a maximum output and configure the workplace so that it favors the employees to the fullest since they play a significant role in the production process.

If any particular workers are facing challenges while rotating valves, they should be reassigned to another suitable position that would be more favorable to their health.When the workers are healthy, they will not have to miss work; therefore, work will continue, ensuring that production continues smoothly throughout the year.

Company XYZ management should make sure that it follows the appropriate procedure in coming up with correct occupational regulations. It will help to guide the manner in which employees engage themselves in various activities within the company. It will also contribute to guiding the employees on what they should undertake whenever there are cases of injury or whenever some paramount issue needs to be addressed.

Company XYZ should come up with a work plan that ensures all employees are given a work break during particular shifts. It will help in a huge way to reduce the various ergonomics hazards to which the workers are exposed. Additionally, it will contribute to breaking the monotony of work and therefore lead to the reduction of strain, which is a major factor that contributes to the development of musculoskeletal disorders (Armstrong, 1993).

Engineering Controls

"Engineering controls are distinct as modifications to the workstation layout, selections and use of tools within the work surroundings, or changing the process or product of the job to reduce worker experience to risk factors" (Linton, 1990, p. 43).

Ergonomic controls do not always give out the desired effect since they fail to take into consideration additional factors such as data flow and feedback between operators and machines, and they require a detailed understanding of the manufacturing process (Bernard, 1997).

In many ergonomic applications, it is important to keep in mind the production process and types of equipment available (Bernard, 1997, p. 457). "This requires an engineering strategy to ergonomics, something that is not easy to put in place unless the analyst has a setting in both design and ergonomics" (Bernard, 1997, p. 458). Ergonomic applications focus on the use of machines and devices to eliminate or mitigate risk factors. Automation is most often the ideal manufacturing control because it involves eliminating the worker from performing the task. Automation can be a solution even if the job has little or no potential for injury. If a particular task is repetitive and mundane and does not provide much job satisfaction, the worker can be replaced with an automaton that will perform the same functions with less chance for error.

Additional engineering controls involve redesigning the workplace to minimize exposures. This may involve modifying the worksite or the tools or changing the working environment by

creating more lighting or adjusting the temperature of the worksite's atmosphere. The implementation of power tools to the production process is also considered an engineering control. Power tools are often used to eliminate repetitive motions that would otherwise be performed physically by the worker. However, there are also risk factors that come with the use of such power tools, one example being vibration.

Having sufficient administrative and engineering controls is a vital part of integrating an effective ergonomic program into an association that is new to such methods. However, once the program is established, the system's controls will work together as cost effective manner to ensure that the program is meeting the upper management's expectations and goals.

Provide Appropriates Training to Workers

The activities involved in the process of rotating valves are very mechanical, and they cannot be automated. Therefore, they simply have to be done by human beings. Such a situation calls for the need to ensure that the person undertaking such activity is properly trained to handle such tasks. Refinery unit operators should be taught the correct posture and placement of hands. They should ensure that all the work which they engage in is handled in the correct manner. It will help the organization to avoid the huge cost assumed as a result of the employees' injuries due to the use of wrong postures which eventually leads to the development of disorders. Additionally, this will ensure optimum performance by the refinery unit operators (Yoonton, 1990).

Provision of an appropriate management structure that ensures contact is well established with the employees who are at lower levels of the organization in imperative. Such a measure will help to ensure that all employee grievances are passed to the management, and it becomes

possible to promptly take control of situations that may lead to the development of health complication among the employees.

Tools for the Assessment of Ergonomics

A suitable process should be followed in the course of ensuring that ergonomics within XYZ is implemented, namely, using a systematic approach when undertaking an ergonomic risk analysis for the refinery unit department in the industry (Da Costa, 2010).

Analyze the Entire Company

First and foremost, the management should compile a list of all departments in the organization and identify the various ways that the workers in these different departments are being affected by ergonomic risk factors as they carry out their daily activities (De Looze, 2003). In this case, the department in question is associated with the refinery unit operators, where the major event is rotating valves whenever different units are being shut down or when they are turned on (Yoonton, 1990). Then the team that is tasked with identifying the various ways of improving ergonomics within the organization needs to identify the different unhealthy postures that the employees adopt as they carry out their work. It will help in pinpointing exactly where the problem is, and therefore, it will contribute to making it much easier to approach with solutions that can assist in avoiding the problems associated with strain.

It is important that the team undertakes an initial tour of the facility so that they can see firsthand the way that the valves are operated. It will prevent a situation where policies relating to ergonomics are being rolled out by hearsay (Del'Anno, 2009). Allowing the ergonomic implementation team to see firsthand the difficulties that the employees go through as they undertake their duties will help to provide a clearer picture of ergonomic risk factors in the industry. Also, they will be able to see for themselves how the company is undertaking its

operations, and therefore it will be possible to get information on areas that should be improved by conducting a few interviews with the employees (Konz, 2000).

Regulatory Compliance Ergonomics Currently Falls under Occupational Safety and Health Act (OSHA)

The General Duty Clause states that every company must provide a safe working environment for employees. The managers should ensure that the working conditions for employees are favorable and free from hazard by complying with regulatory laws and requirements.

Health and Safety Performance

Health and safety performance is a vital element in maintaining a well-trained, motivated workforce. Ergonomic improvements almost always have a positive impact on health and safety. Based on David's (2005) research, this can be observed by looking at the savings regarding direct and indirect medical costs. Direct medical costs include workers' compensation payments and insurance premiums. Indirect costs are often less viable and always increase when injuries occur. Examples include time to manage and treat injuries, costs to recruit and train replacement workers, overtime or lost productivity and costs.

Direct costs can be tracked to a particular risk management incident. This should also involve setting up a good health and first aid delivery system, such as by employing an occupational health nurse, giving significant health education to workers, and creating a good referral system for complicated cases.

Review Company History on Musculoskeletal Disorders

The most suitable information on MSDs can be obtained by examining the health records of employees who have worked within the organization in the past. Other sources of information

are insurance files, and these should be reviewed so as to identify how many employees ended up complaining of various complications associated with MSDs in the past. It will help in the identification of a trend, and therefore it will be easier to understand the manner in which solutions should be developed (Buehn, 2009).

Analyze the Data Obtained From the Employees

The most appropriate people who can help the team to identify and understand the rate of development of ergonomic risk factors within the organization are the individuals tasked with undertaking these duties. They are also the people who can help the team to identify the most suitable areas that need improvement. An appropriate discussion with the employees working within the organization is the best way to understand the various risk factors that are facing them.

Tools Used in the Assessment of Ergonomics

The various methods that will be outlined contribute to determining sections of an organization where there is need of placing control so as to limit the existence of ergonomic risk factors. It is important to develop an evidence-based scientific approach in the process of identifying various ergonomic risk factors. The major goal, in this case, is to create a clear understanding of the different risk factors in existence within the organization and then quantify them. The next process that should follow is to improve the conditions of refinery units in a manner that is adequately measurable (Buehn, 2009). The improvements can be made by ensuring that all the workers who are involved in rotating valves can properly perform these duties. Employees assigned the duties of refinery unit operators should be healthy and active for them to carry out their duties sufficiently (Drinkaus, 2003).

To achieve this, Company XYZ can make a study of ergonomics a continuous process that can be used in the course of identifying various risks within the company. It can also help to

ensure that chance factors are reduced depending on the objectives and a clear analysis of the working area.

WISHA Lifting Calculator

The WISHA Lifting Algorithm is a tool that was developed by the Washington State Department of Labor and Industries, and it was designed in accordance to research carried out by NIOSH on the primary causative agent of back injuries. The tool can be used in undertaking an adequate assessment of risks based on a broad range of activities that involve manual lowering and lifting activities. Additionally, it can be employed in the analysis process of the main lifting tasks that need to be screened further while applying the advanced NIOSH lifting algorithms (Aigner, 1988).

NIOSH Lifting Equation

Occupational safety professionals in the process of assessing the manner in which materials are typically handled within the organization usually employ the NIOSH Lifting Algorithm. The device further analyzes the risks associated with lowering and the lifting of heavy machinery within the organization. The equation takes into consideration the variables related to a particular task so as to come up with the most appropriate practice that can be used in lifting heavy machinery (David, 2005)**.**

The primary product obtained while using NIOSH Lifting Algorithm is known as the recommended weight limit (RWL). It helps to outline clearly the most suitable weight size that any worker in an organization should carry over a period of eight hours since in most cases this is the number of hours that is allocated to a shift (Bernard, 1997).

Rapid Entire Body Assessment

This particular tool should be most suitable in the case of analyzing operations within Company XYZ. Because the device deals with the analysis of the entire body posture, it is typically adopted by the whole body in the process of undertaking various activities within the organization. Therefore, it is suitable for evaluating the postural MSD and the various ergonomic design risks that are associated with the job that is being undertaken (Hignett, 2000).

A single page is used in the process of evaluating the appropriate posture that should be utilized in performing a particular task, the best movement, and actions that should be utilized. Additionally, factors such as the most suitable number of times that a task should be repeated and the appropriate force that should be employed in the process of undertaking tasks are analyzed (Vandergrift, 2012). Scores are then assigned to each activity based on the different parts of the body. The different sections are elbows, forearms, neck, back, knees, wrists, and trunk. After suitable data has been collected for each region of the body, the score will be provided. A table that is provided on the form is then used to create the variables associated with the possible risk factors. After all of this is completed, it is possible for one to obtain scores that can be used to identify the level of MSD hazards (Linton, 1990).

Rapid Upper Limb Assessment

The Rapid Upper Limb Assessment is frequently used in the process of assessing the different postural and biomechanical load requirements that are associated with a task/condition on the trunk, neck, and the upper extremities of the body. Also, in this case, a one-page form is provided for the evaluation process of the force, repetition of a task, and posture that should be used in doing a particular task. According to the scores obtained for each region of the body,

tables on the form are used in the process of compiling the variables associated with a particular risk until a score representing the risk level of MSD is obtained.

Prevention Approaches of Ergonomic Disorder

Employers are responsible for ensuring that the working environment favors the operation by workers in the most suitable manner. While workers are engaged in their daily activities (Torgler, 2005), the severity and number of MSDs frequently result from physical overexertion. It comes at a cost since the management is the one that is supposed to take care of the billing requirements that accrue due to the employees' ill health. When the management can take care of the various factors that affect the health of employees, they will be able to reduce the associated health costs.

Offer Management Support to the Employee

It is crucial for the management to engage itself fully in ensuring that an appropriate ergonomic policy and regulation is adopted for use within the company premises. Clear goals should be outlined, and the various objectives associated with the implementation of ergonomics should be discussed with the workers. Also, the most appropriate responsibilities should be assigned to the employees so as to help them provide the most suitable output (Sauser, 2017).

Involve Workers in the Process

Employee participation in the course of developing an appropriate ergonomic approach is the most suitable. When the workers are involved in the assessment of the working conditions in which they operate, it brings out an aspect of a successful ergonomic implementation plan as it helps to ensure that workers can fully welcome the measures that are being adopted. Management should also identify and provide the most appropriate information to workers so that they can understand the things that they should avoid as they carry out their duties.

Identify Existing Issues

Workers should always be encouraged to report some of the most pertinent issues affecting them as they perform their daily activities in the workplace. Employers should encourage employees to report MSD symptoms early enough. This can help in a major way to accelerate the assessment of the job and the manner in which suitable improvement can be implemented (Urwin, 1998).

Summary

This study has focused on the various ergonomic factors affecting the working condition of employees in Company XYZ. The difference between ergonomic risk and risk factors has also been clearly outlined since, in this line of work, there are many. The tasks involved in rotating large valves are considered to be some of the heaviest within this industry. Therefore, adequate measures should be undertaken to ensure that the workers involved within the refinery units can perform efficiently.

Based on this review, we can conclusively confirm that ergonomics is a significant aspect that should be incorporated into Company XYZ. The relationship that exists between the workers in an organization and the machinery systems that have been established for operation is very dependent on ergonomics. The systems that have been developed for use help to determine the design of the environment in which workers should operate. It is evident that many steps can be used to evaluate the ergonomic risk factors in the organization. Therefore, it is possible for managers of Company XYZ to mitigate the risks that are associated with risk factors of ergonomics, which include the force that is exerted while trying to turn the valves. Injury to the musculoskeletal system is very dangerous as it typically leads to a reduction in the quality of life.

Since the task is very repetitive, the management of Company XYZ should acquire tools for the workers to use in the process of rotating valves (Karwowski, 2001).

Employees in XYZ are exposed to ergonomic hazards due to the turning of valves, which adversely affects them, causing health effects and complications like musculoskeletal disorders and cumulative trauma disorder. These risks also affect the productivity and economic status of employees and the company.

This chapter talks about the possible effects of ergonomic hazards to employees of XYZ and measures that can help in controlling the effects according to the research focused on operating large rotating valves. This study also looks at the various effects of ergonomic hazards on the employees of XYZ, describing how they are present and how they come about in the work area. The study also gives measures on how to prevent and control these hazards from occurring, hence making sure that there is a reduction of the effects on workers. This should be done through a well-established relationship between the worker and the management. The study pays most attention to hazards that come along as a result of massive rotating of large valves, concluding that ergonomics is an integral part of the industry to help protect workers from hazards, therefore reducing the effects on workers and ensuring safety in work areas. The management team at XYZ should adopt all these measures to improve the productivity of workers and the relationship between operator and machine.

Chapter III: Methodology

The purpose for undertaking this study was to comprehend the manner in which ergonomics hazards affect the workers at XYZ Company as they rotate valves at various sections of the company and also to look into the various measures that are undertaken by the management to address the ergonomics issues. XYZ workers have to perform their duties on a daily basis, and some of these are repetitive which leads to the development of health complications. Therefore, the company employees are the primary target respondents of this research. The research is entirely based on the activities carried out by the workers during the process of rotating large valves at various sections of the companies. The research is undertaken entirely within the XYZ premises as it targets the workers who have been employed there.

In this chapter, the surveyor explains how the process of sample selection was conducted, all the instrumentation used in data collection, the procedures followed in data collection and the data analysis process. Also, this chapter addresses the limitations of the research methodology that affect the validity of this investigation.

Subject Description and Selection

The population of this study is limited to the employees who work within the refinery section, who are typically referred to as the "Refinery Unit Operators." The primary task that the workers on shift undertake is rotating large valves. This is typically done when the factory units are being opened or closed. Some of the major valves that need to be rotated are the gate valves, plug valves, pump valves, and those that regulate the flow of liquid between vessels. There are more than 100 valves spread all over the company, and the employees are typically required to rotate not less than ten valves in a single day. XYZ has four distinct sections which need to be covered by a single worker for each shift. Due to this, the employees engaged in the data

collection activity were only four. Before data collection, a subject consent form was developed. The form stated that all participation was voluntary and that all data acquired would not reveal the subject's identity. It also stated that all records from the research were confidential, securely stored and destroyed once the study was concluded.

The sample also included members of the management staff. These members were supervisors of the refinery section and generally heads of the firm XYZ Company. The management was involved in the interview as they offered oversight into policy making within the company.

Instrumentation

The researcher chose the Rapid Upper Limb Assessment (RULA), a quantitative screening assessment method best suited to the study. The posture of the upper limbs, mainly arms and wrists, was assessed using RULA score sheet; the range of movement for each body site is divided into sections. These sections are scored so that the score 1 is given to the range of movement or working posture where the risk factors present are minimum. Higher scores are allocated to sites of the movement range of more extreme postures indicating an increasing presence of risk factors causing load on the structures of the body segment. The exposure scores according to RULA are divided into four (0, 1, 2, and 3) exposure categories, which are negligible, low, medium and high respectively. (See Appendix A)

To support this assessment, the researcher interviewed management about processes and procedures to understand the safety culture of company XYZ, employees exposure to MSDs and training of employees. Interviews were completed with the management aimed at collecting information on the number of recordable injuries, measures taken to safeguard the workers and the trend of workers exposure to work related MSDs. The interviews were done using an

interview sheet/questionnaire that was completed by the respondents (See Appendix B for Managers Perception Survey). Interview questions were constructucted to extract relevant information relating to the company's safety culture from the management.

A laptop computer was used to transcribe the interviews. It was also used to analyze the information gathered from the questionnaires. Using the Microsoft Office software, MS Word was used to type the report while MS Excel was used to input information obtained and develop tables from it.

Data Collection

The data collection procedure was conducted as follows:

- Previous existing records of ergonomic analysis of the rotating valves were obtained from XYZ Company's records through the management's assistance.
- All respondents were briefed on the interview undertakings and guidelines. Verbal consent was used to proceed with interested parties.
- Willing participants were issued consent forms, which they signed to show they agreed to the terms and conditions after the analysis.
- Interviews were conducted with willing participants of the management staff who had signed consent forms.
- Responses obtained were collected and presented in tables.
- The data was then applied to the ergonomics assessment method: RULA.

Data Analysis

Information from the questionnaires was studied, processed and placed in the tabular form. The tables were used to describe various quantifiable data obtained.

Data from the interviews and observation from the operation of the valve were analyzed by the researcher and used to arrive at conclusions. The data collected from the questionnaires and visual observations made during the research was ultimately analyzed using RULA ergonomics assessment method.

All relevant information and data were obtained and analysed to address the primary purpose of the study and offer recommendations and conclusions based on the findings.
The findings were then expressed in the results section of this report. The findings were also used to publish the recommendations and conclusions of the study in their respective sections of the paper.

Limitations of the Study

The following were limitations faced throughout the research:

- The willingness to participate by those interviewed may alter the information given for own self-gains.
- The study was only focused on the rotating valves and thus cannot be applicable in any other sector of the XYZ Company.
- The research was time bound to four months which is still not enough to gain sufficient data.
- The study's findings and recommendations are only applicable to XYZ Company.
- RULA ergonomics assessment tools are only primary screening tools.

Chapter IV: Results

The purpose of this study was to understand the way in which ergonomics hazards affect the employees at XYZ Corporation as they rotate valves at various sections of the company and also to look into the different measures that are undertaken by the management to address the ergonomics issue. The researcher established goals to assist in evaluating the purpose of the study. The goals described to help included:

- Analyze previous existing records of ergonomic analysis of the rotating valves obtained from XYZ Company's records through the management's assistance.
- Perform an employee survey through the filled questionnaires to determine the employees' perception of the hazards and management policies to address the ergonomics issue.
- Conduct a management survey through the filled questionnaires to determine the management's knowledge of the hazards and management policies to address the ergonomics issue.

Data Presentation

There were three goals this study tried to reach. They will be discussed below.

Goal #1: Analyze previous existing records of ergonomic analysis of the rotating valves obtained from XYZ Company's records through the management's assistance. Though it was hard to convince the management to dispense such information to the researcher, they ultimately complied. Previous existing records of ergonomic analysis of the rotating valves and injury records dating back to three years were obtained. The aim of the study was to conduct an analysis of the injuries and loss that employees reported to their supervisors over the three calendar years of 2014, 2015 and 2016. Tables 1 and 2 indicate an increase in MSDs in 2015.

From information obtained, it was determined that, due to a decline in revenue, the company chose to adopt certain economic measures to remain in business. These measures included an increase in the production rate without a corresponding increase in human and production resources. This implies that XYZ Company was challenging their employees to produce a higher quantity of the product without any additional workers or overtime, which may have contributed to an increase in the XYZ Company recordable incident rate. Such challenges caused fatigue and discomfort to employees due to awkward postures and increased the frequency of repetitive motions, which then resulted in the MSD rate increase.

Tables 1 and 2 contain data recorded from XYZ Company's data logs. These tables indicate a trend in work injuries by using the injury frequency rate based on the level of exposure (the number of person-hours worked in the plant). The XYZ's Company log data are summarized from 2014, 2015 and 2016 calendar years over a 31-month period.

Table 1

XYZ Company Recordable Injury Trend

Calendar Year	2014	2015	2016
Recordable	10	10	5
DART	6	8	4
MSDs	4	5	1
Hours Worked	501,654	374,542	280,907

Note: *Incidence Rate = (# entries in XYZ 300 log / 200,000/Hours worked)*

MSDs Incidence Rate for all manufacturing (rotating valves).

Table 2

XYZ Incidence Rate Trend

Calendar Year	2014	2015	2016	2014 BLS
RIR	4	5.3	3.6	2.3
DART Rate	2.4	4.3	2.8	1.3
MSDS Rate	1.6	2.7	0.7	2.4

According to Table 2, the number of days away, restricted or transferred (DART) rate was not stable in 2015 when compared to the averages of 2014 and 2016. In 2015, the DART rate jumped to over three times the national average. The DART rate declined in 2016 compared to 2015 but was still twice the average. The musculoskeletal disorder rate as displayed in Table 2 was inconsistent in the last three years. The MSDs rate remained below average in the year 2014 and 2016 but was above average in 2015.

Goal #2: Perform an employee survey through the filled questionnaires to determine the employees' perception of the hazards and management policies to address the ergonomics issue. RULA was developed to evaluate the exposure of individual workers to ergonomic risk factors associated with upper extremity MSDs. Based on the evaluation worksheet, scores are entered for each body posture, force and repetition. After the data for each body region is collected and scored, tables on the worksheet are used to determine a single score based on the risk factors compiled. The single score generated represents the level of MSDs risk associated with the evaluated task . Below is the table of the evaluation conducted for this

analysis. A complete worksheet of the RULA evaluation is attached in Appendix A of this project.

Table 3

XYZ RULA Score for Worker Rotating Valves Operation

Body Parts	Posture	RULA Score
Upper Arms	45 to 90 degree	4
Upper Arms	Shoulder raised	1
Lower Arms	0 to 60 degrees and 100 degree above	2
Lower Arms	Lower Arms cross body midline	1
Wrist	Flexion of<15 degree	2
Wrist	In mid-range of wrist twisting range	1
Wrist	Side Bent	1
Neck	< 20 degrees	2
Neck	Neck is Side Bending	1
Trunk	0 to 20	2
Trunk	Trunk is twisted	1
Legs	Legs well supported on platform	1

Table 4 below represent the scores of different body parts in relation to force, muscle and posture exacted while rotating various valves at company XYZ. This data is obtained with the data of Table 3 and a preformulated matrix on the worksheet (See appendix A). The table in turn

is used to arrive at the grand score which represent the level of MSD risk associated with the operation of valves in company XYZ

Table 4

XYZ RULA Grand Score

Body Parts	Posture Score	Muscle Score	Force Score	Total
Arm and Wrist	6	1	1	8
Neck, Leg and Trunk	4	1	1	6

RULA Grand Score is 7.

The RULA grand score from the analysis shows that investigation and immediate implementation of changes are required due to the high risk level of MSDs in the current mode of operations.

Goal #3: Conduct a management survey through the filled questionnaires to determine the management's perception of the hazards and management policies to address the ergonomics issue. Two managers were questioned in this survey: the first and second shift supervisors completed the questionnaire. To achieve this goal, a management-based questionnaire was used to collect information. The first question was a two-part question, with the first part seeking to know if they had reports of the number of ergonomic-related injuries in the past years in the rotating valves sections. The managers responded indicating that there were five MSDs in the past year at these distinct sections.

The second part inquired if the managers had noticed any observable trends in the ergonomic related injuries. One of the managers said that the number of MSDs had risen at the rotating valves section, but it was after an increase in the volume of production at these sections. The other manager indicated that the employees' age seemed to significantly impact their

tendency to develop minor MSDs as three of the five reported cases were from the oldest workers of the lot.

The second question was to determine the most difficult part of solving the ergonomic-related problems. One of the managers commented on how it can be difficult to single out a particular task of the process frequently causing the injuries in order to mitigate it. The other manager commented on how the specifics of each employee are vastly different. For example, height reach requirements may vary proving difficult to make accommodation. It's therefore difficult to modify sections to meet each worker's specific needs.

The third question inquired if any specific changes or modifications could be made of the parts to mitigate hazards. Both managers outlined that there was a need for the sections to be modified to standards that better fit the employees' individual needs.

Question four inquired about the managers' perceptions of the company's training programs. Both indicated that they believed the safety training program had a positive impact on reducing the occurrence of MSDs.

The fifth question asked for their perception of the implications that the management policies have on the sections' injury rates. One manager indicated that there was a need for additional funding for improvements in technology and tools and also the need for workstation modifications and automation. However, both managers agreed that the company was playing an active role in addressing the ergonomic issues and offered ample support to the affected employees.

Question six asked the managers to recommend any changes that they might make to improve existing management policies. One of the managers indicated that the management could enlighten the employees on after-work stretching techniques that would significantly reduce the

occurrence of MSDs. The other manager suggested that there was a need to improve on the method the company used to communicate on safety performance throughout the enterprise. Safety performance is currently addressed during quarterly staff presentations while it may be more efficient to receive more frequent communication on safety performance.

The final question asked the managers to suggest any new management policies that they might recommend. Neither manager had comments on this issue.

Chapter V: Conclusions and Recommendations

The purpose of this study was to understand the manner in which ergonomics hazards affect the employees at XYZ Company as they rotate valves at various sections of the company and also to look into the various measures that are undertaken by the management to address the ergonomics issue. The researcher established goals to assist evaluating the purpose of the study. The goals described to help included:

- Analyze previous existing records of ergonomic analysis of the rotating valves obtained from XYZ Company's records through the management's assistance.
- Perform an employee survey through the filled questionnaires to determine the employees' perception of the hazards and management policies to address the ergonomics issue.
- Conduct a management survey through the filled questionnaires to determine the management's knowledge of the hazards and management policies to address the ergonomics issue.

Restatement of the Problem

In Company XYZ, workers are exposed to ergonomic health risks, especially motion injuries related to rotating of large valves. This action is repetitive, and there are more than one hundred valves in the company whereby each worker is expected to rotate at least ten valves a day. The valves involved include gate valves, plug valves, pump valves and those that regulate flow of liquids in/between vessels.

The Rapid Upper Limb Assessment (RULA) was the analysis tools used to process data obtained. RULA was used to evaluate workers rotating large valves by paying considerable attention to joint angles, posture and muscle force of upper extremities.

There were two perception surveys used: one to determine the workers' understanding of the ergonomic hazards due to rotating large valves and their management, and the second to determine management's knowledge of workplace hazards. Analysis of previous records on ergonomics hazards due to rotating large valves was also used.

Major Finding

The RULA survey tool generated a score of five, which indicates that further investigations should be done and changes made to the process as soon as possible. Worker and management perceptions are that age of employees and workplace design is contributing to repetitive motion injuries due to rotating of large valves especially if the valve is placed very high. "When the workstation is too high, workers must maintain an elevated shoulder posture during work. This leads to fatigue of shoulder muscles and results in pain and cramps in shoulder and neck region" (Dennerlein, 2006, p. 46). It is indicated older workers were more at risk, and it was hard to design the workplace in a way that would favor all workers that are of different heights and builds. It's also clear that workers are not aware of the ergonomic hazards that they are exposed to while doing their work, though there are warnings about ergonomic hazards. The management is not clear on dangers that come along with the rotating of large valves.

Conclusion

This study suggests several conclusions:

- The RULA survey tool used to evaluate the rotating of large valves indicates that a positive change in the operation of the valve should be introduced as soon as possible. This was concluded because of joint angles, posture and muscle force used.
- Based on the employees' observations, it is concluded that a significant number of workers suffer from discomforts, especially due to the position of valves and the

difference in physique among workers, which may lead to pinching grips and may cause discomfort, fatigue, and injury.

- The conclusion made from the supervisor's perception is that age is also a major factor in repetitive motion injuries; age of above fifty years is a major contributing factor and the inability to modify sections with valves to meet every worker's specific needs.
- The analysis of previous records on ergonomic hazards leads to a conclusion that an increase in production with no increase in workforce or improvement of instruments also causes an increase in repetitive motion injuries.

Recommendations

From the conclusion, the following controls are recommended to reduce exposure to risk factors that arise from the constant turning of large valves in XYZ.

Engineering controls. Use machines that help in turning the valves. This not only helps in avoiding ergonomic hazards, but also contributes to increasing the production and quality in XYZ Company.

Administrative controls. Promote more job rotation so as to reduce the action of repetitively turning large valves. This also equips the workers with other skills and makes them multidimensional so that they can work in any part of Company XYZ.

Provide safety training programs to the employees to ensure they keep safe while working. Employees should be made aware of unsafe conditions and acts that leave them exposed to ergonomic hazards, and they should be taught after-work stretching to help in reduction of musculoskeletal disorders. The company should also improve its communication in safety performance and be doing it frequently. This plays a major role in advocating for a safety culture among the enterprise.

Employers should inspect the workplace frequently to make sure exposure to hazards is as minimal as possible by investigating the causes of hazards and trying to curb them.

Areas of Further Research

It would be important to study more deeply into the injuries resulting from constant turning of large valves.

Pinch grips have come up in the research, and it would be important to study more on pinch grips and how they can be prevented.

It would also be important to look into the various types of valves that can be used to make the task of turning valves less demanding and reduce the discomforts and injuries that come from repetitively turning the large valves.

References

Aigner, D. S. (1988). Estimating the size of the US hidden economy from time series data. In W.A. Barnett, E.R. Berndt, & H. White (Eds.), *Dynamic econometric modelling* (pp. 224-243) Cambridge (MA.): Cambridge UP.

Armstrong, T. J. (1993). A conceptual model for work-related neck and upper-limb musculoskeletal disorders. *Scandinavian Journal of Work, Environment & Health,* 73-84.

Bernard, B. P. (1997). Musculoskeletal disorders and workplace factors:a critical review of epidemiologic evidence for work-related musculoskeletal disorders of the neck, upper extremity, and low back. *Musculoskeletal Disorders and Workplace Factors*, *56*(78), 456-499, 786-945.

Bramson, J. B. (1998). Evaluating dental office ergonomic risk factors and hazards. *The Journal of the American Dental Association,129*(2), 174-183.

Buehn, A. K. (2009). Shadow ergonomy and do-it-yourself activities:The German case. *Journal of Institutional and Theoretical Ergonomics*, *165*(4), 701-722.

Da Costa, B. R. (2010). Risk factors for work-related musculoskeletal disorders: A systematic review of recent longitudinal studies. *American Journal of Industrial Medicine,53*(3), 285-323.

David, G. C. (2005). Ergonomic methods for assessing exposure to risk factors for work-related musculoskeletal disorders. *Occupational medicine,55*(3), 190-199.

De Looze, M. P. (2003). A participatory and integrative approach to improve productivity and ergonomics in assembly. *Production Planning & Control, 14*(2), 174-181.

Del'Anno, R. (2009). A complex approach to estimate the shadow ergonomy: The structural equation modelling In M. Faggini & T. Lux (Eds.), *Coping with the complexity of economics* (pp. 110-130). Heidelberg: Springer Publishing Company.

Dempsey, P. G. (2005). A survey of tools and methods used by certified professional ergonomists. *Applied ergonomics,*, 36(4), 489-503.

Dennerlein, J. T. (2006). Different computer tasks affect the exposure of the upper extremity to biomechanical risk factors.*Ergonomics, 49*(1), 45-61.

Drinkaus, P. S. (2003). Comparison of ergonomic risk assessment outputs from Rapid Upper Limb Assessment and the Strain Index for tasks in automotive assembly plants. *Work,21*(2), 165-172.

Gainer, R. D. (2008). History of ergonomics and occupational therapy. *Work*, *31*(1), 5-9.

Hägg, G. M. (2003). Corporate initiatives in ergonomics—An introduction. *Applied Ergonomics, 34*(1), 3-15.

Hess, J. A. (2004). A participatory ergonomics intervention to reduce risk factors for low-back disorders in concrete laborers. *Applied Ergonomics, 35*(5), 427-441.

Hignett, S. (2000). Rapid entire body assessment (REBA). *Applied Ergonomics*, *31*(2), 201-205.

Karwowski, W. (2001). *International encyclopedia of ergonomics and human factors (Vol. 3).* New York: Crc Press.

Keyserling, W., Stetson, D., Silverstein, B., & Brouwer, M. (1993). A checklist for evaluating ergonomic risk factors associated with upper extremity cumulative trauma disorders. *Ergonomics*, *36*(7), 807-831.

Konz, S. A. (2000). *Work design:Industrial ergonomics (Vol. 1).* Boca Raton, Florida: Holcomb Hathaway Publishers.

Linton, S. J. (1990). Risk factors for neck and back pain in a working population in Sweden. *Work & Stress, 4*(1), 41-49.

Marras, W., Lavender, S., Leurgan, S., Fathallah, F., Ferguson, S, Allread, G., & Rajulu, S. (1995). Biomechanical risk factors for occupationally related low back disorders. *Ergonomics, 38*(2), 377-410.

Marras, W. S. (2006). *Fundamentals and assessment tools for occupational ergonomics.* Boca Raton, Florida: CRC Press.

Muggleton, J. M. (1999). Hand and arm injuries associated with repetitive manual work in industry: A review of disorders, risk factors and preventive measures.*Ergonomics, 42*(5), 714-739.

Öztürk, N. (2011). Investigation of musculoskeletal symptoms and ergonomic risk factors among female sewing machine operators in Turkey. *International Journal of Industrial Ergonomics*, *41*(6), 585-591.

Salvendy, G. (2012). *Handbook of human factors and ergonomics.* New York: John Wiley & Sons.

Sauser, R. (2017). *UCLA Ergonomics - Preventing MSDs*. Retrieved March 6, 2017, from https://ergonomics.ucla.edu/injuries-and-prevention/preventing-msds.html.

Shuval, K. (2005). Prevalence of upper extremity musculoskeletal symptoms and ergonomic risk factors at a Hi-Tech company in Israel. *International Journal of Industrial Ergonomics, 35*(6), 569-581.

Torgler, B. A. (2005). Attitudes towards paying taxes in Austria. An Empirical Analysis. *Empirica, 32*(2):231-250. Retrieved from http://ideas.repec.org/a/kap/empiri/v32y2005i2p231-250.html

US Bureau of Labor Statistics, *Journal of Global Industrial Ergonomics,* (56) 678-697.

Urwin, M. S. (1998). Estimating the burden of musculoskeletal disorders in the community: The comparative prevalence of symptoms at different anatomical sites, and the relation the relation to social deprivation. *Annals of the rheumatic diseases, 57*(11), 649-655.

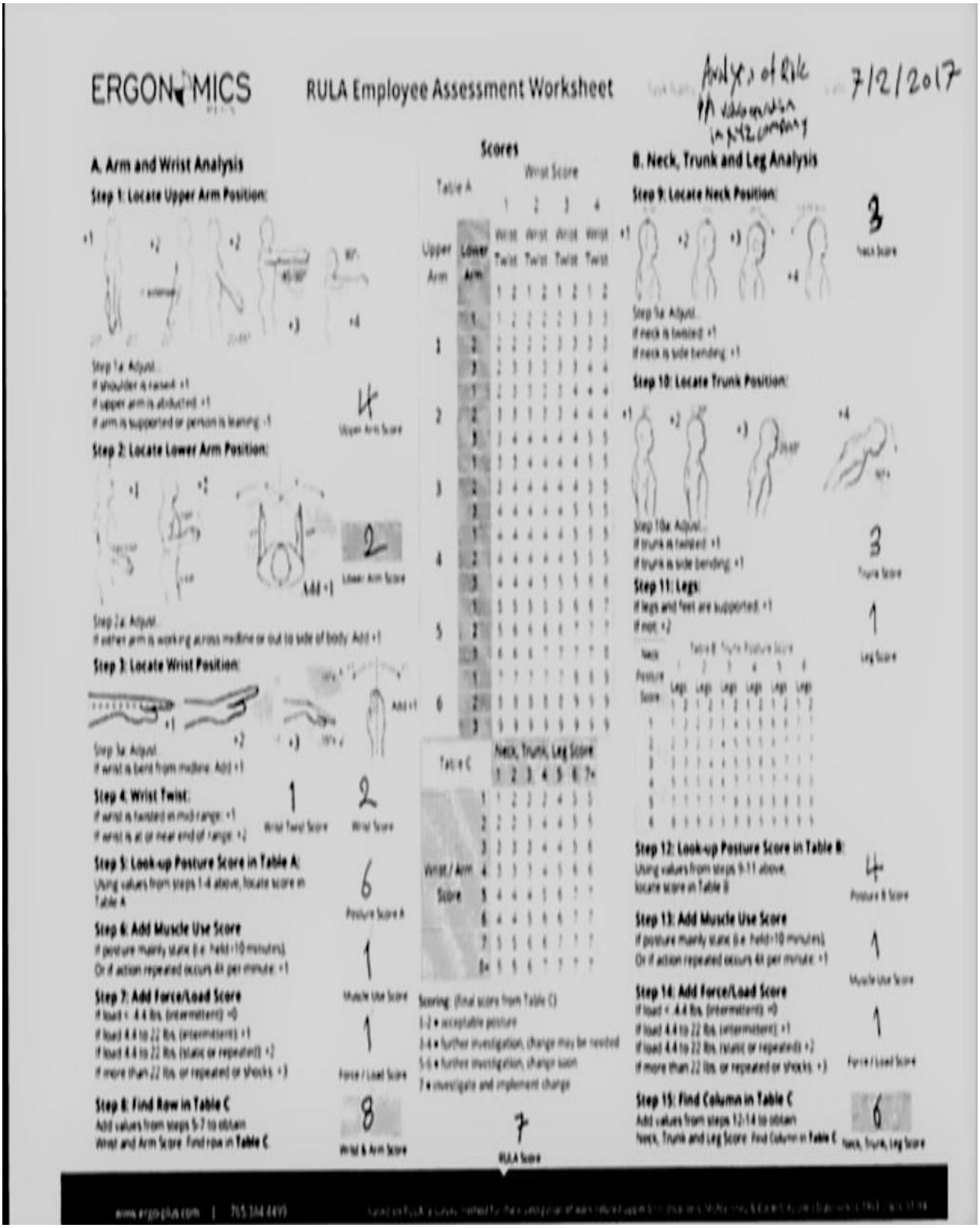
Van der Beek, A. J.-D. (1998). Assessment of mechanical exposure in ergonomic epidemiology. *Occupational and Environmental Medicine*, 55(5), 291-299.

Vandergrift, J. L. (2012). Physical and psychosocial ergonomic risk factors for low back pain in automobile manufacturing workers. *Occupational and Environmental Medicine, 69*(1), 29-34.

Yoonton, S. (1990). *The ergonomic analysis of valve adjustment tasks for refinery unit operators at Koch petroleum group.* Menomonie, WI: Doctoral dissertation, University of Wisconsin-Stout.

Zinchenko, V. P. (1998). *Fundamentals of ergonomics*. Moscow: Progress Publishers.

Appendix A: RULA Assessment Worksheet



Appendix B: Managers Perception Survey

Managers Interview Questions

1. a. Do you have an idea of the number ergonomic related injuries reported in the past years? _____

   b. Have you noticed any trend in the reporting of ergonomic related injuries?

   _____

2. As a manager, what in your opinion is the most tasking part of solving work related ergonomic problems? _____

3. What modification in the company's operation should be done to mitigate employee's exposure to work related ergonomic injuries?

   _____

4. a. Is there any ongoing safety program for employees of the company?

   _____

   b. If yes to 5a above, is there any impact on the employee's injury rates?

   _____

5. What is your perception on the impacts of management policies on the section of the company?

   _____

6. What recommendation would you made toimprove existing management policies?

   _____