FEASIBILITY STUDY ON MUSCULOSKELETAL DISORDERS AND SAFETY RELATED ISSUES AMONG MAINTENANCE WORKERS AND COMPETENT CHARGEMAN IN A VOLTAGE INSTALLATION

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Field of Study: Ergonomic study

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ABSTRACT

Electrical work associated with musculoskeletal disorders and safety issues related with voltage installation is common issues to discuss. In addition, the work of voltage installation is a work that requires repetitive motions, awkward postures, manual handling and involves with heavy equipment such as wind circuit breaker, vacuum circuit breaker and meter installation. In the utility industry, voltage installation work must be done by skilled and semi-skilled workers as it involves electrical operations that a failure to operate properly may cause injuries and accidents at workplace. The main objectives of this feasibility study were to evaluate musculoskeletal disorders during voltage installations and evaluate safety issues during voltage installations. Research methods namely Hazard Identification, Risk Assessment and Control measure (HIRAC) to assess safety issues for voltage installation work, and Nordic musculoskeletal questionnaire (NMSDQ) to assess musculoskeletal disorders in voltage installations were employed. 20 respondents from engineering department of Malakoff Utilities Sdn. Bhd. Data were analyzed to get the crucial information to identify weaknesses in aspects of safety issues and musculoskeletal disorders during voltage installation work. The data showed that safety issues for voltage installation work, work safety hazards, risk assessment and control measures were in low likelihood but the severity was high because they involved electric shock and fatality was at stake. For body posture when performing the job steps in the voltage installation work, the likelihood was low but the severity was moderate and there was no existing control measure. Finally, Recommendation in this study, for employees and employers, if taken seriously might help them reducing the risk of fatality and musculoskeletal disorders while performing voltage installation work as well as reducing medical costs. For employers, their returns on

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investment are in terms of work efficiency, and medical and store maintenance cost reductions.

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ABSTRAK

Kerja elektrik yang berkaitan dengan gangguan "musculoskeletal" dan juga isu keselamatan voltan masukan adalah perkara-perkara sering diperkatakan. Selain itu, kerja pemasangan voltan adalah kerja yang memerlukan gerakan yang berulang-ulang, postur tubuh yang janggal, pengendalian manual dan peralatan berat seperti pemutus litar angin, pemutus litar vakum dan pemasangan meter. Dalam industri utiliti, kerja voltan masukan memerlukan pekerja-pekerja mahir dan separa mahir kerana ia melibatkan kendalian elektrik yang jika tidak dikendalikan dengan baik boleh mendatangkan kecederaan dan kemalangan di tempat kerja. Objektif-objektif utama kajian kemungkinan ini dilakukan adalah untuk menilai kerja berkaitan gangguan "musculoskeletal" semasa kerja voltan masukan dan menilai isu keselamatan semasa kerja pemasangan voltan. Kajian kemungkinan ini menggunakan "Hazard Identification, Risk Assessment and Control measure" (HIRAC) sebagai alat untuk menilai isu keselamatan untuk kerja voltan masukan dan "Nordic musculoskeletal questionnaire" (NMSDQ) di gunakan dalam menilai gangguan "musculoskeletal" dalam kerja pemasangan voltan dimana pekerja selenggara dan jurugegas elektrik sebagai responden; jumlah 20 orang responden dipilih di jabatan kejuruteraan Malakoff Utilities Sdn. Bhd. Data kemudiannya dianalisis untuk mendapat keputusan bagi mengenalpasti kelemahan dalam aspek isu keselamatan dan gangguan "musculoskeletal" semasa kerja-kerja voltan masukan. Data menunjukkan bahawa isu keselamatan untuk kerja voltan masukan, langkah-langkah kerja dalam pengenalpastian bahaya, penilaian risiko dan langkah kawalan berada dalam colum kemungkinan rendah tetapi keterukan adalah tinggi kerana melibatkan renjatan elektrik dan boleh melibatkan kematian. Untuk postur badan semasa melakukan langkah-langkah kerja dalam kerja voltan masukan, kemungkinan adalah rendah tetapi keterukan adalah sederhana dan tidak mempunyai langkah kawalan sedia ada.

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Dengan adanya kajian ini, hasil dapatan dan cadangan dapat dimanfaatkan oleh pekerja dan majikan yang mana mereka dapat mengurangkan risiko kematian dan gangguan "musculoskeletal" semasa melakukan kerja-kerja voltan masukan selain dapat mengurangkan kos perubatan akibat kerja-kerja yang dilakukan. Akhir sekali, untuk pihak majikan pula, mereka mendapat pulangan hasil pelaburan dalam projek voltan kemasukan dalam bentuk kcekapan kerja dan pengurangan kos perbelanjaan perubatan dan kos selenggara peralatan akibat kecuaian dalam melakukan kerja.

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This study is dedicated to my parents; Darduri bin Tumin and Khuzaimah binti Samadi who always teach me to be a good person in Dunya towards Akhirah, remind me to consistently contribute to society and show me what true love is all about.

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LIST OF SYMBOLS AND ABBREVIATION

DOE	:	Department of Environment
DOSH	:	Department of Occupational Safety and Health
EHS	:	Environmental, Health and Safety
FMA	:	Factories and Machinery Act.
HOD	:	Head of Department
HSE	:	Health and Safety Executive
NADOPOD	:	Notification of Accidents, Dangerous Occurrence, Occupational Poisoning and Occupational Diseases
NIOSH	:	National Institute of Occupational Safety and Health
MSD	:	Musculoskeletal Disorder
NQMSD	:	Nordic Questionnaire Musculoskeletal Disorder
RULA	:	Rapid Upper Limb Assessment
REBA	:	Rapid Entire Body Assessment
HIRAC	:	Hazard Identification, Risk Assessment and Control Measure
VCB	:	Vacuum Circuit Breaker
ACB	:	Air Circuit Breaker
PCD	:	Proof Circuit Dead

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ECM	:	Existing control Measure
LTI	:	Lost Time Injuries
OI	:	Occupational Illness
PD	:	Property Damage
CA and PA	:	Corrective Action and Preventive Action
CM	:	Control Measure
OSH	:	Occupational Safety Health
OMP	:	Occupational Safety Health Management Program
MC	:	Medical Leave
KV	:	Kilo Volt
HT	:	High Tension

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CHAPTER 1: INTRODUCTION

1.1 Background

Musculoskeletal disorders have turned out to be progressively regular worldwide during the previous decades. It is a typical reason for work-related disability among workers with considerable financial results because of worker's remuneration and medical costs. Different work-related components have been built up as inclining the disorders. Musculoskeletal disorders cause chronic pain and impedance for many individuals, force substantial expenses on society for treatment, debilitated leave and retirement and diminish profitability in working life (1996).

Mechanical components add to the expansion of these issues and by large impact the indications. To help characterizing the issue and its relationship to work factors, expanding interest has been guided in numerous nations to the improvement of techniques to gauge and record musculoskeletal side effects. Questionnaire turns out to be the clearest method for gathering the fundamental information (Kuorinka, et al., 1987).

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Statistics about musculoskeletal disorder incident cases happened in Malaysia is as shown in Figure 1.1.

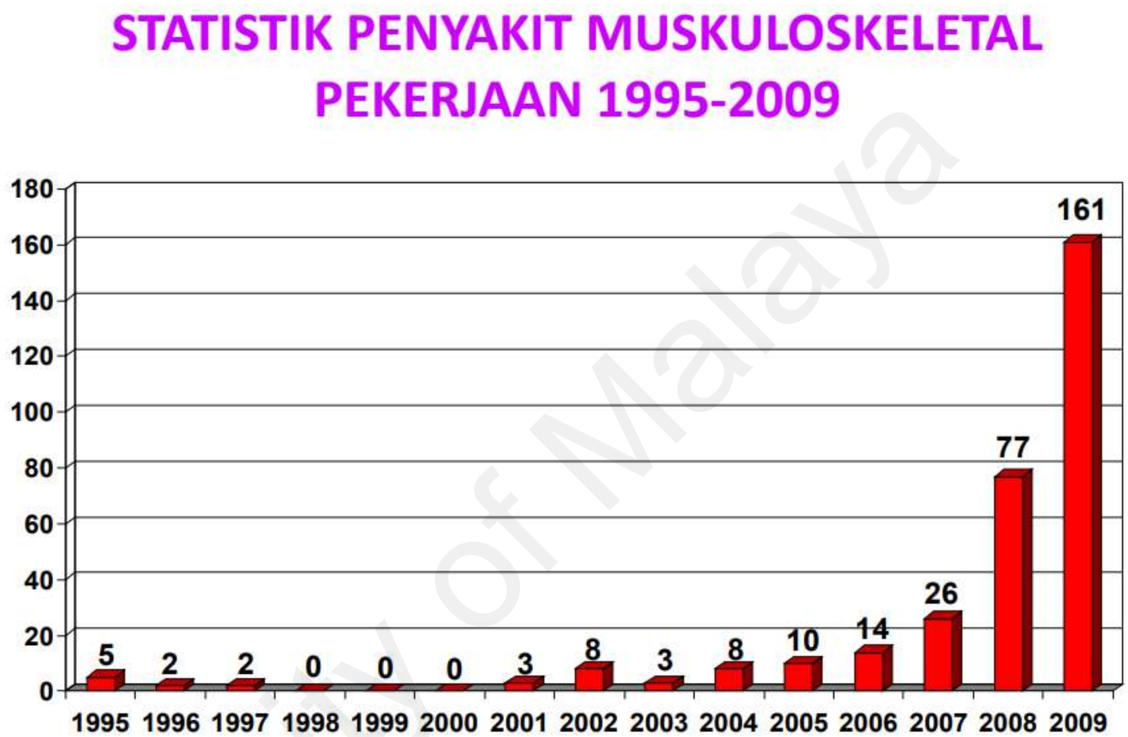

Figure 1.1: Statistics of Musculoskeletal Disorder Cases in Malaysia (Dosh, 2018).

From Figure 1.1, in year 2005 the number of cases was 10, 14 cases in 2006, 26 cases in 2007 and the highest was 161 cases in 2009 (Dosh, 2018).

Consistently, the significance of the upkeep work, and in this manner has developed a likewise of maintenance administration. The far reaching motorization and automation has lessened the quantity of generation faculty and has expanded the capital utilized underway equipment and common structures. Subsequently, the portion of representatives working in the maintenance region has expended, and additionally, the division of maintenance spends on the aggregate operational expenses. In refineries, for example, it I not remarkable that the upkeep and tasks divisions are the biggest that each contains around 30% of aggregate labors.

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Besides, by energy costs, support spending can be the biggest piece of the operational spending plans (Dekker, et al., 1996). ARC flash hazard evaluation has been conducted on numerous electrical engineers amid the previous couple of years. IEEE 1584 "Guide for Performing Arc-Flash Hazard Calculations" covers three-phase ac electrical systems (Doan, et al., 2010). In principle, it ought to be conceivable to build up an arrangement of conditions for the maximum arc flash energy of standard electrical calculations that would give moderately high assessed incident energy values (Doan, et al., 2010).

1.2 Problem Statement

Most Malaysian workers work according to guidelines stated in the Standard of Work procedure and standard operation procedure without considering their internal health. Most 30-year-old workers face the risk of developing disorders involving the muscles, tendons, joints, back pain and disorders of musculoskeletal. They are unaware of this issue, not exposed to the dangers of musculoskeletal disorders and have a lack of knowledge about this disorder. Most Malaysian employers only follow the line of deeds, rules and standards of work without thinking about the health of employees. Additionally, some employees ignore and take it easy safety aspects when performing jobs that might cause accidents.

The number of occupational injuries involving days away from work due to Carpal tunnel syndrome and Tendonitis injuries are 5920 and 2710 respectively, with an incidence rate of 0.59 and 0.27 per 10,000 workers (Borneo Post online, 2016). Previous study states that around (25%) of the roughly 6300 grown-up gets musculoskeletal damage over the most recent a year, of which (83%) identified with the movement (Borneo Post online, 2016). Muscle pain and disability is a vital general health conditions that influence around (30%) (Range 14%-47%) of the aggregate population (Borneo Post online, 2016). Muscle pain and disability is a vital general health conditions that influence around (30%) (Range 14%-47%) of the aggregate population (Borneo Post online, 2016)

A total of 811 electrical accident cases were reported and investigated by Energy Commissioner throughout the years between 2002 and 2015 (Energy Commissioner of Malaysia, 2015). This involved 403 death cases and 408 non-fatal cases. In 2015, a total of 48 cases of electrical accidents were recorded involving 30 deaths and 18 non-fatal cases. This showed a decline of 23.8% compared with year 2014, which were 63 cases. The number of non-fatal accident cases also decreased by 50.0% from 36 cases to 18 cases while fatal accidents increased by 11.1% from 27 cases to 30 cases. As of 2015, the average number of electrical accident cases occurred over the last 14 years was 55 cases a year. The number of electric accident victims per million of total electricity users has begun to decline since 2006 until 2015 from 12.71 to 6.52 persons. The death rate for one million electricity users has dropped from 5.51 persons in 2007 to 2.37 person in 2013 (Energy Commissioner of Malaysia, 2015). However, it started to increase to 3.09 persons in 2014 and 3.34 persons in 2015. Analysis of electrical accidents in Malaysia showed that Sabah recorded the highest number of accidents which was 17.0 % of total, followed by Selangor at 11.0%. Inadequate installation or maintenance was a major cause of electrical accidents in Peninsular Malaysia and Sabah since year 2002 until 2015 with a percentage of 35.5% (288 cases), followed by the procedure safe work was not complied at 30.3% (246 cases) and public work activities near electrical installations at 11.5% (93 cases). Failure to perform scheduled maintenance on electrical installations and failure to install protective devices on electrical wiring systems were some of the factors among others unsafe conditions that contributed to imperfect installation and maintenance (Energy Commissioner of Malaysia, 2015).

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This feasibility study was conducted on workers from Malakoff Utilities Sdn Bhd. to investigate musculoskeletal disorder awareness and to be acquainted with age range that most likely to be effected by musculoskeletal disorder attacking on body system during work at workplace and work station,. This study was also intentionally to ensure that all workers utilize and followed full safety requirement at workplace and workstations.

1.3 Research Questions

1. What are the common types of musculoskeletal disorder in Malakoff Utilities Sdn. Bhd.?
2. What are the safety risk factor related issues happen during voltage installation task in Malakoff Utilities Sdn. Bhd?

1.4 Research Aim

The aim of this research was to ensure workers to have a knowledge and awareness about musculoskeletal disorders and implement safety at workplace and be familiar with the ways to prevent musculoskeletal disorder in musculoskeletal system body, accident and incident when handling electrical work including voltage installation.

1.5 Research Objective

1 To evaluate the risk of work-related musculoskeletal disorders during voltage installation.

2 To evaluate safety risk related issues on voltage installation work.

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1.6 Research Scope

1. Maintenance workers (19 workers) and competent chargeman (1 person) working at substation as a workstation with distances range between 1 and 2 kilometers from one substation and another (substations are owned by Malakoff Utilities Sdn Bhd.).
2. Feasibility study on maintenance workers and competent chargeman during voltage installation using MSD questionnaire, Rapid Upper Limb Assessment (RULA), Rapid Entire Body Assessment (REBA) and HIRACS as methodologies.

1.7 Significance of Research

This research was important as a reference for safety and health practitioners to predict and mitigate the musculoskeletal disorder effects on maintenance workers and competent chargeman. The feasibility study of musculoskeletal disorder and related safety issues among maintenance workers and competent chargeman might bring a new perspective among workers and employers to deal with problems and consequently maintain the productivity of the company and the health of workers.

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CHAPTER 2: LITERATURE REVIEW

2.1 DEFINITON OF MUSCULOSKELETAL DISORDER

Work-related musculoskeletal disorders cause incessant pain and functional hindrance for many individuals, force overwhelming expenses on society for treatment, debilitated leave, retirement and decrease profitability in working life. Work-related musculoskeletal issues cover extensive variety of provocative and degenerative disease and furthermore incorporate some less notable conditions of pain and useful disability. Aggravations of ligaments (tenosynovitis), particularly in the lower arm wrist, elbow, and shoulder, have high prevalence and rates in occupations including delayed times of dreary and static work (1996). Myalgias which has a long course and numerous instances of chronic· hindrance with weakness to continue work have been accounted for. Pressure of nerves-entanglement disorders happens particularly in the wrist and lower arm, causing pain and loss of sensibility and strength. With continuous exposure, utilitarian hindrance may stay forever. Degenerative scatters happen in the spine, more often than in the neck and low back districts, and in the hip and knee joints. Such disarranges are regular in the all-inclusive community regardless of ages (1996).

The disorders depicted above are most precisely portrayed as business related. Work related disorders is, as per World Health Organization (WHO) definition is multi factorial, in which workplace and execution of work contribute fundamentally to the causation of the illness. A work-related hazard factor is one among a few variables (in spite of the fact that not really a sufficient factor) that reason, incite, or disturb an inert disorders (1996).

2.2 CAUSES OF MUSCULOSKELETAL DISORDER

2.2.1 Conceptual Model

Primary avoidance of work related musculoskeletal disorders calls for lessening introduction to chance variables. The effects of hazard factors are additionally altered by singular limit. Figure 2.1 clarifies the intricate interrelationships between various hazard factors at work, singular variables, and musculoskeletal disorder. The model recommends that redundant or supported small scale injury (mechanical or physiologic) happening over time, bargains the trustworthiness or working of particular tissues and structures of the musculoskeletal framework (Armstrong T, et al., 1993).

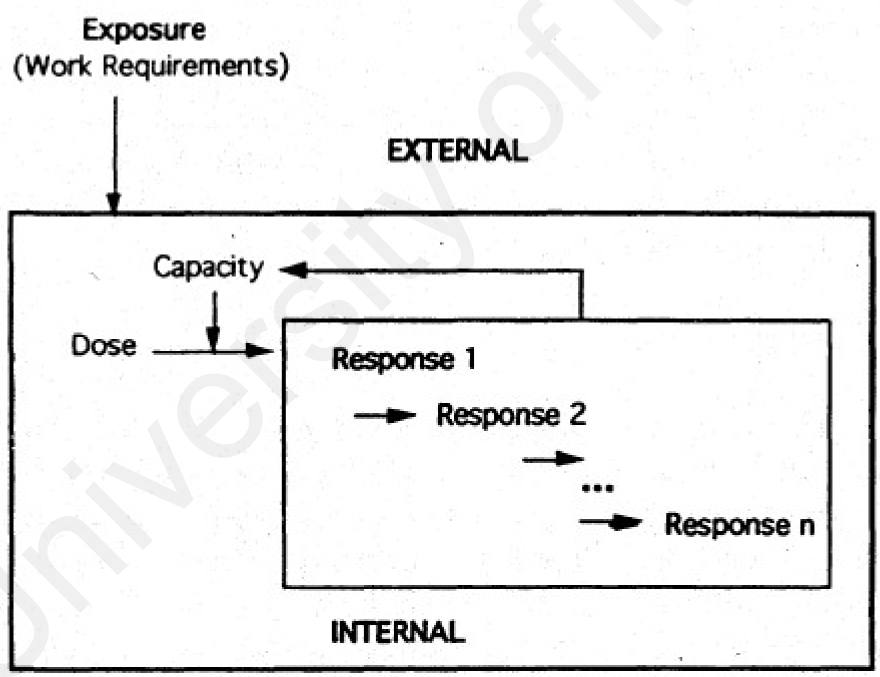

Figure 2.1: Conceptual Model for Work-Related Musculoskeletal Disorders (Armstrong T, et al., 1993).

Exposure alludes to the outside components of work that create inward dosages (e.g. metabolic demands or tissue loads). These measurements exasperate the inner condition of

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the individual (tissue disfigurement, creation of metabolites, pain, uneasiness), bringing about internal responses that perhaps interceded by singular limit (Armstrong T, et al., 1993).

The course shows along the line depict systems of musculoskeletal disorders. In a perfect world, from existing logical learning, this model could be utilized to assess the probability that a particular arrangement of working conditions would cause a. particular musculoskeletal disorders.

Be that as it may, while a large number of the real business related variables have been recognized, there is considerable logical discussion about the levels of hazard related with most normal exposures. By large, for the most well-known work exposures, for example, tedious work or manual handling, there are scarcely any broadly acknowledged international rules or gauges proportionate to limit (Silverstein BA, et al., 1986).

2.2.2 Manual Handling

Manual handling incorporates with conveying, holding, and pushing and pulling objects. In numerous epidemiologic examinations, manual handling has been distinguished as a hazard factor for low back pain, and furthermore for bear disorders. Normally a two-to-triple increase in danger of low back clutters has been found in occupations that include manual lifting of overwhelming items. Lifting activities out of work related setting, e.g., the lifting of articles or kids weight 25 pounds or more, frequent lifting with broadened arms and contorting while lifting, are related with an expansion of disorder risk. It would appear to be, hence, that confirmation, gathered out of work environment distinguishes manual handling with exercises as expanding the hazard for the advancement of a back confusion or damage (1996).

In a substantial number of studies, clearly manual handling initiates static loads because of awkward stances and entire body vibration while driving vehicles. In the business

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related hazard, factors for low back disarranges are recognized: substantial physical work, lifting, conveying, pulling, pushing, turning, twisting, other non-impartial trunk stances, engine vehicle driving, sitting, repetitive work, work disappointment, and injury. In spite of the fact that hazard factors for low back scatters additionally incorporate different kinds of exposures, the significance of manual handling is generally perceived (Smedley, et al., 1995).

2.2.3 Repetitive Work

In repetitive work, similar errands are rehashed for significant lot of time. Ordinarily, the work pace is quick and the work requires frequent developments or efforts of a similar body part. Repetitive work of the hand is a regular issue at work yet different parts of the body likewise might be influenced. Repetitiveness of work is described reasonably in terms of the quantity of efforts per unit time and the proportion of work to rest (1996).

At the point when the recurrence of efforts is too high or the recuperation time is too short, workers may encounter uneasiness and disability in playing out their occupations. The arrangement to overexertion proceeds with tissue feasibility might be debilitated prompting further side effects and diminishing limit. In extraordinary cases, exercises at work and the day by day living might be debilitated. Progressive increment in physical efforts has brought consequences for the musculoskeletal system (Weber, et al., 1980).

2.2.4 Static Work

Static or managed work suggests that one or a few body locales are raised, twisted, bents, or reached out for delayed periods. In this way muscles, ligaments and joints are exposed to enduring burdens without rest for recuperation. Static posture of neck, arms and trunk are normal in numerous occupations, e.g. welders and building workers. A few epidemiologic investigations have exhibited high prevalence of myalgia and ligament

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disorders, related with static posture (Kant, et al., 1992). Myalgia is particularly liable to happen in the shoulder and neck muscles that balance out the head and lift the arms. Static postures are portrayed as far as the length of efforts in the given position and the level of most extreme quality utilized. Static efforts can be evaluated utilizing perceptions, time studies, video analysis and electromyography (EMG) (Kant, et al., 1992). The instrument of muscle and ligament injuries in static postures prone to be inadequate supply of vitality. Mechanical pressure because of expanded intramuscular weight may additionally block the course and fiery response may grow, in the end prompting degeneration and diminished quality. Muscle strands with checked degenerative changes have been discovered more often in muscle biopsies from patients with business related perpetual myalgia (J. Sanchez, et al., 1979).

2.2.5 Vibration

Exposure of human body to vibration is known to create an expansive assortment of abstract sensations and disorder influencing the musculoskeletal, vascular, anxious and engine system (Maeda, et al., 1998). Control devices expose their administrators to hand-arm vibrations. The hand-arm vibration disorder (HAVS) mostly comprises of three phenomena; vibration-prompted white finger, tactile aggravation in the hand and musculoskeletal disorders of arm, for example, tendinitis and degenerative joint disorders. The vehicle, for example, trucks and tractors are a regular hotspot for entire body vibration introduction. Entire body vibration have been related with back pain and pain in the shoulder and neck likewise be connected (Griffin, M. J., 1990).

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2.3 TYPE OF MUSCULOSKELETAL DISORDER

2.3.1 White Finger

The vibration vitality created by pneumatic, electrical or engine driven devices when transmitted to the hands and arms of workers first delivers tingling took after later by numbness. With an expanding introduction time, subject to the vibration qualities (increasing speed power and recurrence range), the subject at that point sees that his fingers go white at whatever point contacting chilly protests or presented to a cool domain (Taylor, W., 1982). This irregular whitening originally saw at the tip of one finger bit by bit, however, continuously stretches out to the base of the fingers, all digits on the two hands being last included. The accelerating factor in all cases is exposure to cold. Nevertheless, in exceptionally serious propelled cases, the thumbs are only here and there engaged with these occasional assaults which typically last from 10 to 40 minutes (Taylor, W., 1982).

As the condition advances the level of coldness which actuates a less vasospasm and the condition may wind up lasting even in summer. Neurological manifestations of pain and paresthesia may happen freely of the vasospastic assaults. In cutting-edge cases, loss of manipulative mastery, and advanced rot may happen (Noël, B., 2000).

2.3.2 Tendinitis

Rotator sleeve tendinitis is a typical reason for shoulder pain in adults and may result in an impressive inability. In the event that the degenerative changes in the rotator sleeve ligaments have no relationship with side effects, as has been recommended, rotator sleeve tendinitis may, in fact, be a self-constraining disorder (Chard, et al., 1988).

Tendinitis is the aggravation of the ligament and results from smaller scale tears that happen when the musculotendinous unit is intensely over-burden with a ductile force that is

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too overwhelming as well as excessively sudden. Tendinitis is as yet an exceptionally normal conclusion; however, research progressively reports that what is believed to be tendinitis is typically tendinosis (Khan, et al., 2002).

The enormous increment of participation in focused and recreational games exercises has prompted an expansion of abuse disorders. The most widely recognized abuse disorder at the lower leg concerns the Achilles ligament. Traditional treatment, indeed, even drawn out, does not take care of the issue for each situation. In addition, a lot of significant sport idleness may undermine the competitors' sport vocation. The term Achilles tendinitis is regularly used to allude to three particular conditions, each with various pathology, manifestations, and treatment. The three areas of Achilles ligament injuries are the ligament bone intersection (addition tendinopathy), 2 to 6 cm over the inclusion into the calcaneus (Achilles, tendinitis), and at the muscle-ligament intersection (tennis leg). The pathologic condition examined in this paper was confined to constant abuse injuries at the region of 2 to 6 cm over the addition at the calcaneus (Nelen, et al, 1989).

2.3.3 Carpal Tunnel Syndrome

Carpal Tunnel Syndrome (CTS) influences around 1% of working-matured individuals and is the most common reason for hand pain in manual employees. CTS is a clinical analysis and does not warrant any further examination within the sight of gentle and suggestive CTS (Saint-Lary, et al, 2015). CTS is identified with pressure and bothering of the middle nerve inside the carpal tunnel in the wrist: an anatomical space limited by the carpal bones dorsally and the stringy flexor retinaculum volarly. CTS remains a baffling and crippling condition normally exhibited to rheumatologists and orthopaedic hand clinicians. It is a compressive neuropathy, which is characterized as a mononeuropathy or radiculopathy, caused by mechanical contortion delivered by a compressive power (Ibrahim, I., 2012). CTS

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is the most surely understood and visited type of median nerve entanglement and records for 90% of all capture neuropathies. An ensnarement neuropathy is an unending central compressive neuropathy caused by a pressure increment inside non-adaptable anatomical structures. CTS is a neuropathy caused by ensnarement of the median nerve at the level of the carpal bones, delimitated by the carpal bones and by the transverse carpal tendon (Ibrahim, I., 2012).

Anything that expands the weight inside the compartment or causes a decrease in the volume of this compartment may even be the side effects of CTS (Saint-Lary, et al, 2015). The likelihood of CTS ought to be considered within the sight of:

1. Paresthesia, dull, throbbing pain, or distress in the hand related with weakness or awkwardness;
2. Fluctuating level of indications with fuel during the evening (nocturnal numbness), intensified by strenuous hand utilize or exercises with looked after stance (driving); and
3. Incomplete help of indications by changing hand stance or shaking the hand CTS (Saint-Lary, et al, 2015).

2.4 Arc Flash

Arc flash hazard appraisal has been on the brains of numerous electrical engineers amid the previous couple of years. IEEE1584 "Guide for Performing Arc-Flash Hazard Calculations" covers three-phase ac electrical systems (Doan, et al., 2010). In principle, it ought to be conceivable to build up an arrangement of conditions for the most extreme arc flash energy of standard electrical figuring that would give moderately high evaluated incident energy values. This would be a dc form as contrasted and Lee's ac systems arc flash condition, where the most extreme energy in an ac system fault was the reason for the

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condition distributed in 1982 (Doan, et al., 2010). Despite the fact that it was not predictable at high power levels, perception of arcs at low power recommended a correspondence between the pressure sufficiency and the rate of progress of intensity that may be communicated as an exact equation (Jones, et al.). The Drogue Nadeau experimental relationship into a group of bends relating the separation from the circular segment focuses to viable pressure for arc current ranging from 500 A to 100 kA rms. This graphical investigation fills in as a calculated and commonsense reason for work rehearse rules in regards to safe separations for workers doing assignments with potential for arc generation (Jones, et al).

2.5 Improvement on Musculoskeletal Disorder and Safety Related Issue on Voltage Installation

Accessible information, evaluated above can be utilized:

1. To take after patterns in the events of manifestations or clutters.
2. To screen the levels of hazard factors.

It tends to be contended that our insight is inadequate to examine far reaching activities. The facts confirm that learning about the correct systems of musculoskeletal disorders and quantitative presentation impact connections is yet deficient. These areas require additionally inquire and will give stunningly better devices to counteractive action, particularly as a reason for rules, mandates, and standard. All things considered, accessible research on the connections between work hazard factors and numerous musculoskeletal disorders are uncontroversial, and certain betterment moves should be made at this point (1996). To address the consistently expanding issue of work-related musculoskeletal disorders, counteractive action techniques ought to be created at all levels of society: inter-nation partner, nationally, and locally (1996). Information on the measure of the issue is

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essential for starting legitimate ergonomic intercessions. The work-related portion of the aggregate event of musculoskeletal disorders could have been evaded by an appropriate workplace layout (Westgaard, et al, 1997).

Be that as it may, in spite of the regard for ergonomics, and an extending learning base on customary ergonomic issues, musculoskeletal dissensions at the work environment remain an impressive issue. A few changes in accentuation can be watched. Low back pain was at one time the overwhelming concern. Today, grumblings situated in the lower arm, shoulder and neck are similarly concerned (Westgaard, et al, 1997).

2.5.1 International Level

Global associations, for example, World Health Organization (WHO), International Labor Organization (ILO), International Commission on Occupational Health (ICOH), and International Ergonomic Association (lEA) are assume as vital entities in supporting research, spreading data, institutionalizing techniques, and issuing rules (1996). In the advancement of aversion systems, the global gatherings should work to create standard worldwide phrasing and uniform criteria for characterizing work-relatedness. Furthermore, the gatherings should endeavor to create, approve, and execute a typical grouping of work-related disorders. Besides, the advancement of worldwide ergonomic standards and rules for the plan of work systems ought to be proceeded. Principles must secure all workers and pay little heed to sexual orientation or age (Ibrahim, I., 2012).

2.5.2 National Level

Imperative segments of successful prevention action methodologies incorporate data spread, education, and training at all levels of the administration and populace; powerful utilization of current innovations; reconnaissance and medicinal administration and

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implementation. Each nation ought to create counteractive action procedures in view of national, social and financial conditions (Ibrahim, I., 2012).

2.5.3 Economic Benefit and Incentive

Workplaces that incorporate ergonomic standards are valuable for health and for the economy. Advancement of preventive ergonomic exercises regularly prompts economic benefits, for example, expanded efficiency, diminished non-appearance and enhanced work fulfillment. Data about the economic advantages of ergonomically solid working conditions ought to be spread. Administration duty to aversion is a fundamental for progress, similar to the interest of representatives all the while. National projects should support and advance such duties and cooperation. Work association changes additionally gave reasonable and low-cost implies for diminishing the danger of musculoskeletal disorder. Employment job rotation away from the redundant undertakings is valuable for keeping the over-burden of the specific muscles. Addition of visit short breaks and the arrangement of open to resting corners encourage the recuperation from muscle fatigue. Numerous other one of a kind thoughts created in the local workplace environments supposedly accelerate the working environment change in this way diminishing the danger of musculoskeletal disorders (Kogi, et al., 2003).

2.5.4 Technologies

Devices, hardware, and work environments must be intended to oblige the human body and its impediments. Establishment of ergonomically outlined gear and work systems at the time the workstation is manufactured is preferable and more financially savvy over later adjustment. Present scientific information is adequate to make better planned apparatuses and hardware, which can be more viably brought into the working environment if designers are better prepared in key ergonomic standards. The pace and association of work ought to be changed in accordance with the psycho-social requests set on the workers. While presenting new innovation, consideration must be paid both to great workstation outline and to the human need to impact the work procedure. The most widely recognized tools and hardware ought to be tried and redesigned when fundamental. Ergonomics ought to likewise be connected to the plan and assessment of machinery (Kogi, et al, 2003).

2.5.5 Education, Training and Information

Arrangements assume an essential job in the anticipation of musculoskeletal disorder. Learning of work related hazard factors and additionally work and equipment innovations is fundamental for everybody; fashioners, directors, foremen, generation architects, specialists, and word related recuperate experts involved in the technical and authoritative association of individual work environments. Courses in ergonomics ought to be incorporated into the necessities for scholarly degrees in science, drug, brain research, general health and organization. Employers and exchange associations have a critical job. Employers can model, sort out local and across the nation administrator gatherings to trade learning and give education. Exchange associations can mastermind education and urge workers to take a functioning enthusiasm for enhancing working environment conditions (Waddell, G., 2006).

2.5.6 Legislation

Laws and rules regulation in workplaces are contrast from nation to nation, depend upon present authoritative and social, security systems. It is, thus, unrealistic for us to plot in detail proposals for new enactment to prevent musculoskeletal disorders. Be that as it may, we propose a few standards:

1) At the point when ergonomic norms are defined, it is essential that they be dealt with at least necessities and that they mirror the most recent logical learning.

2) Models ought to be progressively amended to join new learning and to guarantee that preventive ergonomic exercises proceed.

Work inspectorates can act in the preventive work. They can exhort and advise undertakings about conceivable upgrades and punish them if hazard factors for musculoskeletal disorders visit among their work powers or rates of business related musculoskeletal disorder are high (Marras, et al, 2009).

2.5.7 Safety during Switching and Maintenance Works On Voltage Installation.

These tests, over and over, show that bends are very unusual and variable in event, energy, path, and duration. This sort of testing varies enormously from the "bolted fault" kind of short out testing, which considerably more is unsurprising and directly utilized by manufacturer to rate electrical gears. The more energy that is used in an arcing fault, the more noteworthy the possibility for the formation of conceivably ruinous physical force that can hurt individuals and demolish property. These announced reproductions could not straightforwardly quantify the physical and mental results of the exposures to the individuals who may be in vicinity of occasions like our organizing. Workers and hardware might be in danger from electrical curve, even now and again when codes, norms, and methodology are apparently satisfactorily tended to. Arc fault can include electrical contact (shock), intense light, heat, pressure, and clamor, and in addition flying shrapnel. This is not a circumstance for the black out of heart. In reality, workers should "expect the most exceedingly bad" and utilize accessible personal protective equipment. As new bits of knowledge are picked up in the outline and development of electrical systems, human factor contemplation's should be incorporated into their investigation. From the point of view of safety administration, for instance, an electrical installation that in plan and development is "risk decreased' with its door shut yet frequently chipped away at with door open, should be tended to in the two modes: enclosed and breached (Jones, et al).

2.5.8 Hazard Identification, Risk Assessment and Control Measure (HIRAC)

HIRAC shows a far reaching arrangement of phases for the identification of hazard, assessment of risk and the assurance of control measures for the execution of safety and health in the tasks. An essential component of risk assessment is the identification of existing risks, assessing the likelihood or possibility of event and suggesting significant controls (Saedi, et al, 2014).

(a) Hazard Identification

There are also numerous areas related to risk such as heat injury, poor visualization, noise pollution, physical barriers or movement limitations (ergonomics) as well as other unsafe conditions like electrical hazards, spills and mechanical hazards related to equipment. Hazard identification has been comprised of seven principle things to cover each part of risks that made reference to above: Chemical hazard, Electrical, Mechanical, Ergonomic, and Biological Method of control (Saedi, et al, 2014).

(b) Risk Assessment

Risk assessment comprises of a progression of procedures, identified with risk examinations, evaluation of the greatness of risk, judgment on whether the risk is satisfactory or unsuitable, and making and surveying risk control choices, to accomplish this objective. Therefore, after the hazard in the system are recognized, the likelihood of event and size of mischief is resolved, the risk is assessed, and chance control alternatives are assessed dependent on the outcomes. Risk assessment assumes a critical job in the choices made by an association all together execute safety and health arrangements in a judicious way (Saedi, et al, 2014). Risk estimates the probability and seriousness of the mischance/occasion arrangements with the end goal to check the extent and to organize recognized hazard. Risk evaluation should be possible by quantitative, subjective, or semi quantitative methodologies. This investigation comprised of a blend of the three strategies with the end goal to guarantee culmination (Li, et al., 2018). Risk is calculated as follows:

L x S = Relative risk
L = Likelihood
S = Severity

(c) Control

In this examination, control measures were resolved concerning the wellspring of the hazard and the use of engineering controls, administration controls, and personal protective equipment. The controls which were utilized to check and manage hazards were completed by directing a parallel investigation or by looking at with gauges with the end goal to diminish or avoid perils (Saedi, et al, 2014).

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CHAPTER 3: METHODOLOGY

3.1 Research Process

Figure 3.1 is the overview of research methodology.

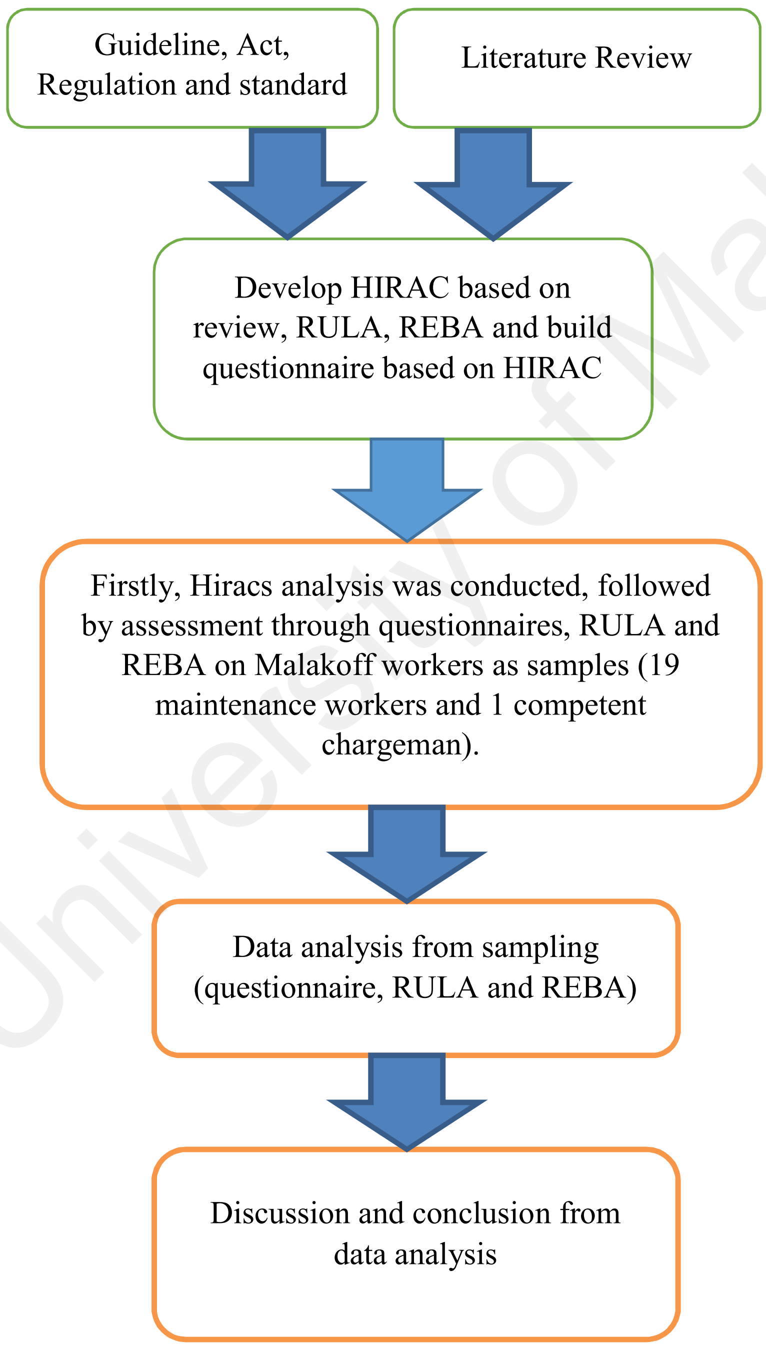

Figure 3.1: Flowchart of Research Methodology.

3.2 Research Area

Research was conducted at Malakoff Utilities Sdn. Bhd. which has its own plant situated at Kuala Lumpur Central. A few workers were selected as samples. Malakoff Utilites Sdn. Bhd. was established in 1996 and the major business is utilities or specifically in Electrical Distribution System and District Cooling System. Research selected Malakoff Utilities because it has central region operation at Malakoff headquarter which can implement the results from analysis and later on distribute them to all Malakoff subsidiaries in Malaysia and other countries.

3.3 Research Sample

This research was conducted on 20 workers as population and samples. The samples were consisted of 19 maintenance workers and 1 competent chargeman. Refer Table 3.1 below:

Table 3.1: Krejcie and Morgan Table (Krejcie, et al., 1970).

N	S	N	S	N	S
10	10	100	80	280	162
15	14	110	86	290	165
20	**19**	120	92	300	169
25	24	130	97	320	175
30	28	140	103	340	181
35	32	150	108	360	186
40	36	160	113	380	191
45	40	170	118	400	196
50	44	180	123	420	201
55	48	190	127	440	205

"N" is population size
"S" is sample size
Shaded region: Number of sample in research

The consistent expanding interest for research has made a requirement for a proficient technique for deciding the sample size should have been illustrative of a given population. In the article titled "Small Sample Techniques," the research division of the National Education

Association has distributed a formula for deciding sample size (Krejcie, et al, 1970). Respondent selected were 20 persons because Malakoff Utilities engineering department is consisted of 19 maintenance workers and 1 competent chargeman. However, they can be a benchmark for Malakoff Utilities in central region and Malakoff Headquarter as the results can be implemented in the company in a whole.

3.4 Data Collection

This research employed some tools to obtain data. Phase 1 involved with HIRAC and in Phase 2, questionnaires, RULA and REBA assessment worksheet were employed.

3.4.1 HIRAC Technique

Hazard Identification, Risk Assessment and Risk Control (HIRARC) has turned out to be the key to activities of arranging, administration and the activity of a business as a fundamental of hazard administration. A hazard recognizable proof and risk appraisal are used to distinguish and assess both existing and potential risks on a work-site and the strategies used to control or eliminate the hazard distinguished (Eves, et al, 2005).

Hazard identification is the process of identifying all hazards in the workplace. There is no method for grouping engineering department in Malakoff Utilities injury and illness hazards. Safety issues analysis on voltage installation work was done using HIRAC to identify safety issues in job steps in voltage installation work. To assess safety management on work field, it is important to check whether it has (Briatico-Vangosa, G., 1994):

1. Regular hazard assessment surveys of operations, equipment, substances and tasks.
2. A system of recording injuries, near misses and identified hazards.
3. Safety procedures for voltage installation work.

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4. Safety training and supervision for new and young employees.
5. Protective clothing and equipment (PPE).
6. Safety training and practice for each new piece equipment.
7. Safety discussion and briefing between employers, contractors and employees.
8. Safety information readily available for hazardous substance.
9. Copied or list of regulations.

Hazard may be identified in voltage installation process are as listed below Saedi, et al, 2014):

1. Environment (light, noise, rain, heat, sun)
2. Substances (pesticide, dusts)
3. Workplace layout (cattle passes, parlor design)
4. Work organization (unnecessary manual handling).
5. Equipment (ladders, squeeze chutes, crowd gates).
6. Farm animals (that bite, kick, butt, crush, toss, infect).
7. Height (roofs, vertical and horizontal silos, manure pits).
8. Electricity (switches, cables, leads, power tools, connection).

Hazard may be identified in work task voltage installation by (Saedi, et al, 2014):

1. Observation.
2. Hazard and risk analysis.
3. Record analysis.
4. Discussion group.
5. Safety audits.
6. Information.

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7. Consumer information

8. Regulations and best practices.

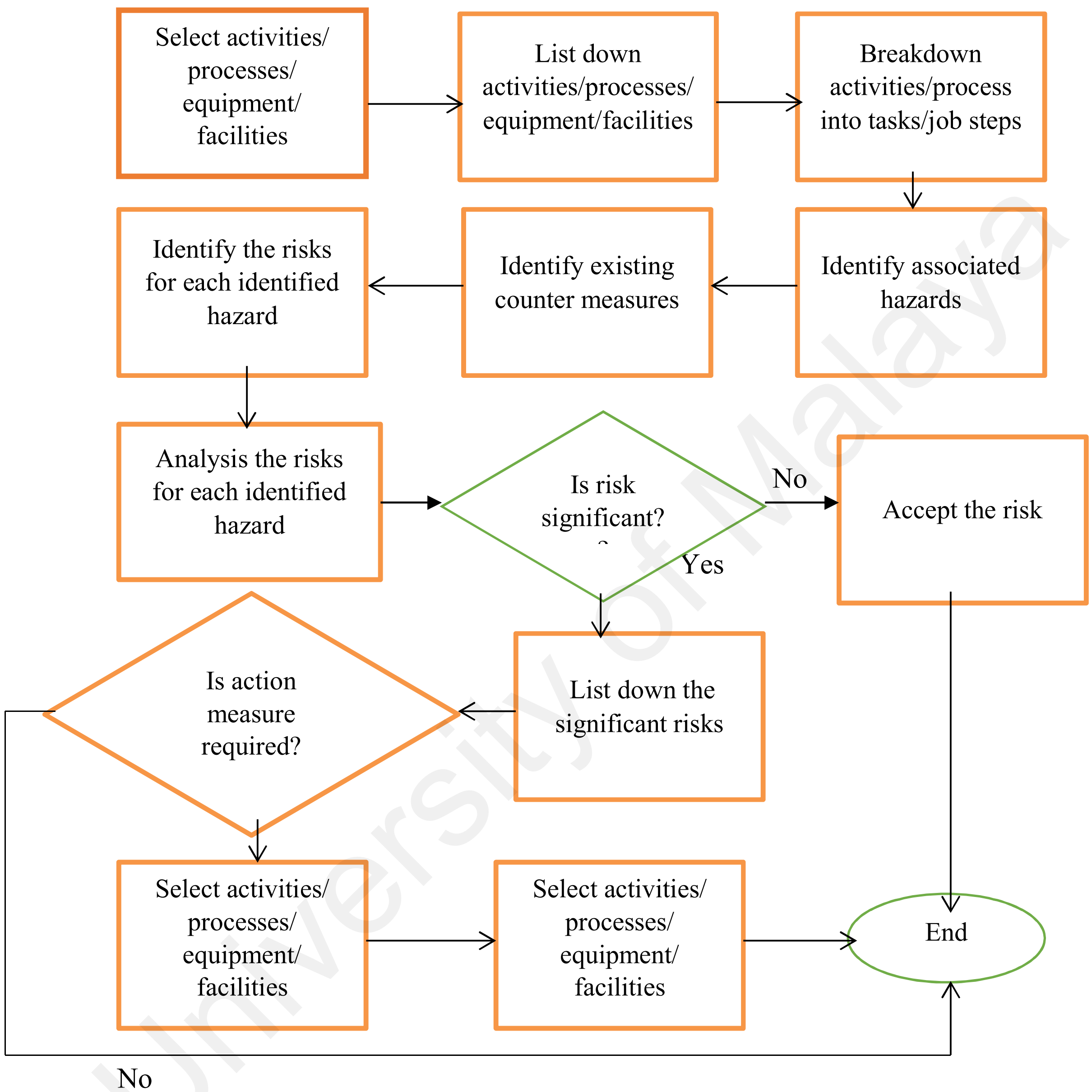

Figure 3.2: Flowchart of Hazard Identification Risk Assessment and Control.

After respondents identified hazard and potential risk before and during work on voltage installation, they filled HIRAC worksheet as shown in Table 3.2 below:

Table 3.2: HIRAC Form (Suhardi, et al., 2016).

Job Step		
Hazard		
Consequences		
Existing Control Measure (ECM)		
Risk Assessment	**Likelihood**	
	Severity	
Risk Level		
Further Control Measure		

Respondent did an assessment on safety issues and identified the hazard. The likelihood and possible severity of injury or harm need to be assessed before determining the best way to minimize the risk. High risk hazards need to be addressed more urgently than low risk situations. Respondents decided that the same hazard could lead to several different possible outcomes. For each hazard, they considered how likely each possible outcome was and recorded the highest priority. After that, respondents analyzed safety issues on HIRAC using flowchart as shown in figure 3.2 above. Respondents evaluated risk using risk score table as shown in Table 3.3.

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Table 3.3: Risk-Based Control Plan.

Total risk	Easier Term	Action and time-scale
I Intolerable (Significant and Unacceptable)	**VH** Very High	Work should not start and has to stop immediately and shall not be started until the risk has been eliminated, minimized or controlled. CA and PA have to be immediately implemented. Work has to remain prohibited until the risk is reduced. Top management attention is needed.
S Substantial (Significant and Unacceptable)	**H** High	Effort should be made to reduce the risk. Risk reduction measures (CA & PA) shall be implemented within a specified time period under OSH Management Program (OMP) or Action Plan. Senior management attention is needed.
M Measure (Significant and Acceptable)	**M** Medium	No additional control measures are required. Current control measure is adequate. However, monitoring (regular inspection, supervision and enforcement) is required to ensure that the existing control measures may be imposed if found practicable and not costly.
T Trivial (Significant and Acceptable)	**L** Low	No further action is required and no documentary records need to be kept. Risk is too trivial.

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3.4.2 Nordic Musculoskeletal Disorder Questionnaire

This survey question focused on musculoskeletal system in human body at upper limb side. The multiple-choice questions were:

1. Work posture (put '/' if applicable)

- ☐ Visual Inspection
- ☐ Check relay protection status
- ☐ Switch 'close' or 'open' VCB activities
- ☐ VCB servicing
- ☐ Lock Shutter
- ☐ Proof Circuit Dead (PCD)
- ☐ Earth switch 'close' or 'open'
- ☐ Lock compartment
- ☐ Cleaning and housekeeping

2. What is the cause of occurrence of pain in related area?

- ☐ Repetitive work
- ☐ Awkward posture
- ☐ Stand up too long
- ☐ Manual handling tools and heavy equipment
- ☐ Pushing and pulling during Rack-in and Rack-out VCB during maintenance

Other questions in questionnaire survey were related with body parts like neck, shoulder, hand/arms, wrist low back and upper back. The questions were to determine the signs of disorders within 12 months. Respondents answer and identify survey suitable to them including survey outside of workplace, example, at home whether routine work and activities

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within 7 days and 12 months expose them to musculoskeletal disorders. This questionnaire referred to Nordic Musculoskeletal Questionnaire (Crawford, et al., 2007).

3.4.3 Rapid Upper Limb Assessment (RULA)

All work movement and posture of respondents were assessed using Rapid Upper Limb Assessment (RULA) and evaluate them from result given by them to analyze awkward movement, posture and handling equipment during work and task at workplace and workstation. RULA assessment has two parts namely part A and Part B. Part A is Arms and wrist analysis and Part B is Neck, Trunk and leg assessment. From RULA worksheet, it has 15 steps in which in part A there are step 1 until step 8 and in Part B there are step 9 until step 15. They are shown in Table 3.4.

Table 3.4: RULA Steps (McAtamney, et al, 1993).

Part A		Part B	
Step 1	Locate upper arm position	Step 9	Locate neck position
Step 2	Locate lower arm position	Step 10	Locate Trunk position
Step 3	Locate Wrist position	Step 11	Legs
Step 4	Wrist twist	Step 12	Look-up posture score in Table B.
Step 5	Look-up posture score in Table A.	Step 13	Add muscle use score
Step 6	Add muscle use score	Step 14	Add force/load score
Step 7	Add Force/load score	Step 15	Find Column in Table C
Step 8	Find row in Table C		

Respondent filled in each question step to get data score on RULA assessment. From Table 3.5, RULA score indicator and level can categorize each score from respondents to MDS Score risk level.

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Table 3.5: RULA Score Indicator and Level (McAtamney, et al, 1993).

Score	Level of MSD risk
1-2	Low Risk, posture accepted
3-4	Further investigate, Change may be needed
5-6	Further investigate, Change soon
6 and above	Investigate and implement change

After respondents answered the question from RULA assessment worksheet, the last score appeared. Later, the data final score was evaluated based on respondents' feedback (Dockrell, et al., 2012).

3.4.4 Rapid Entire Body Assessment (REBA)

Rapid Entire Body Assessment (REBA) is to evaluate working posture that include utilization of the entire body, either statically, dynamic, rapidly changing or in an insecure way, and where manual handling with may happen. REBA is intended to give a fast check of the level of musculoskeletal hazard presented in the assignments being surveyed (L. McAtamney, 2002).

During assessment to get data, respondents were briefed about Rapid Entire Body Assessment (REBA) in general, how to use it and how to fill in the questionnaire. REBA worksheet template was divided into two parts namely Part A which was about neck, trunk and leg analysis, and Part B was arm and wrist analysis. REBA worksheet template consists of 13 steps and respondents answered all the questions in each step to get a final result score before analysis. Table 3.6 shows REBA worksheet assessment steps.

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Table 3.6: REBA Steps (L. McAtamney, 2002).

Part A		Part B	
Step 1	Locate neck position	Step 7	Locate upper arm position
Step 2	Locate trunk position	Step 8	Locate lower arm position
Step 3	Legs	Step 9	Locate wrist position
Step 4	Look-up score in Table A	Step 10	Look-up posture score in Table B
Step 5	Add force/load score	Step 11	Add coupling score
Step 6	Score A, Final score in Table C	Step 12	Score B, Find column in Table C
		Step 13	Activity score

Respondents filled in the answers on REBA worksheet assessment to be analyzed for a final score result. The result was categorized from indication and level on table indication and level. Table 3.7 shows REBA indicator score and level as references on results given (L. McAtamney, 2002).

Table 3.7: REBA Score Indicator and Level (L. McAtamney, 2002).

Score	MSD risk level
1	Posture accepted and negligible risk.
2 to 3	Low risk, further investigation, change soon.
4 to 7	Medium risks, further investigation, change soon.
8 to 10	High risk, investigate and implement change.
11 and above	Very high risk, implement change.

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3.4.5 Limitation for Data Collection

The research had limitations as most respondents were not familiar with musculoskeletal disorders and how the musculoskeletal system in the body. To answer the questionnaire required a lot of time as the researcher needed to explain to respondents what the musculoskeletal disorder was about. In addition, respondents were also not familiar with RULA and REBA worksheet assessments and how to fill in them. With these limitations, the research took a long time to be completed.

Other limitation was in observation in which Malakoff Utilities engineering just recently implemented HIRAC as a safety procedure, thus, respondents had lack of information to identify hazard and evaluate risk control.

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CHAPTER 4: RESULTS AND DISCUSSION

4.1 Introduction

Results were discussed in two phases; phase one was about safety issues related with voltage installation work using HIRAC technique and phase two was about findings from phase one regarding work-related upper limb musculoskeletal disorders among respondents.

4.2 Phase 1: HIRAC Result

The HIRAC feedbacks were successfully received from 20 respondents. The feedbacks were on their identification of safety issues in voltage installation work specifically in switching High Tension (HT) voltage tasks. Hazard can be identified under various categories as listed below:

1. Bio-mechanical and Postural.
2. Physical Environment and workplace design.
3. Mechanical.
4. Electrical.
5. Chemical and toxicity.
6. Biological and Human.
7. Organization and Procedural arrangements.
8. Psycho-social environment and task design.
9. Natural environment.

From the various categories of hazard, a few selected hazards were identified during switching High Tension (HT) voltage in voltage installation task, Table 4.1 until Table 4.22 represent complying identification, analysis and results from hazard finding during job step.

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Table 4.1: Pre-Start Work versus Lack of Knowledge of the Work and Surrounding Risks.

Job Step		Pre-start work.
Hazard		Lack of knowledge of the work and surrounding risks.
Consequences		Expose to unsafe act and unsafe conditions of work area.
Existing Control Measure (ECM)		1. Supervision by competent person 33/11kV. 2. Pre-join briefing on work and safety. 3. Available list of isolation/work instruction.
Risk Assessment	**Likelihood**	L
	Severity	L
Risk Level		T
Further Control Measure		

Table 4.2: Pre-Start Work versus Lack Understanding of Drawing.

Job Step		Pre-start work.
Hazard		Lack understanding of drawing.
Consequences		Wrong isolation.
Existing Control Measure (ECM)		1. Supervision by competent person 33/11kV. 2. Available list of isolation.
Risk Assessment	**Likelihood**	L
	Severity	H
Risk Level		M
Further Control Measure		

Table 4.3: Enter Working Area versus Working Distance.

Job Step		Enter working area.
Hazard		Working distance.
Consequences		Fatigue.
Existing Control Measure (ECM)		1. Company motorcycle.
Risk Assessment	**Likelihood**	L
	Severity	M
Risk Level		M
Further Control Measure		1. Survey assessments.

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Table 4.4: Enter Working Area versus Less Air Fresh.

Job Step		Enter the working area.
Hazard		Less fresh air.
Consequences		Deep breath.
Existing Control Measure (ECM)		1. Portable jet fan.
Risk Assessment	**Likelihood**	L
	Severity	L
Risk Level		T
Further Control Measure		1. Install ventilation fan following working space requirement.

Table 4.5: Enter the Working Area versus Contact with Live Electrical Equipment.

Job Step		Enter the working area.
Hazard		Contact with live electrical equipment.
Consequences		1. Possibility of electrocution/electric shock. 2. Fatality.
Existing Control Measure (ECM)		1. Supervision by competent person 33/11kV. 2. Always aware and alert the condition of work place. 3. Ensure safety at working area. 4. Use proper PPE.
Risk Assessment	**Likelihood**	L
	Severity	H
Risk Level		M
Further Control Measure		

Table 4.6: Visual Inspection versus Standing Too Long.

Job Step		Visual Inspection.
Hazard		Standing too long.
Consequences		1. Fatigue. 2. Neck and shoulder disorders. 3. Back pain.
Existing Control Measure (ECM)		
Risk Assessment	**Likelihood**	L
	Severity	M
Risk Level		M
Further Control Measure		1. Survey assessment.

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Table 4.7: Visual Inspection versus Contact with Live Electrical Equipment.

Job Step		Visual inspection.
Hazard		Contact with live electrical equipment.
Consequences		1. Possibility of electrocution/electric shock. 2. Fatality.
Existing Control Measure (ECM)		1. Supervision by competent person 33/11kV. 2. Always aware and alert on condition of working place. 3. Ensure safety at working area. 4. Use proper PPE. 5. Available portable fire extinguisher. 6. Available safety signage. 7. Available buddy system. 8. Available rubber mats.
Risk Assessment	**Likelihood**	L
	Severity	H
Risk Level		M
Further Control Measure		

Table 4.8: Check Relay Protection Status versus Postural.

Job Step		Check relay protection status.
Hazard		1. Standing too long. 2. Repetitive movement. 3. Working at high altitude.
Consequences		1. Fatigue. 2. Back pain. 3. Neck and shoulder disorders.
Existing Control Measure (ECM)		1. Small ladder.
Risk Assessment	**Likelihood**	L
	Severity	M
Risk Level		M
Further Control Measure		1. Portable mobile ladder. 2. Survey assessment.

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Table 4.9: Check Relay Protection Status versus Contact with Live Electrical Equipment.

Job Step		Checks relay protection status.
Hazard		Contact with live electrical equipment.
Consequences		1. Possibility of electrocution/electric shock. 2. Fatality.
Existing Control Measure (ECM)		1. Supervision by competent person 33/11kV. 2. Use proper PPE. 3. Available rubber mats.
Risk Assessment	**Likelihood**	L
	Severity	H
Risk Level		M
Further Control Measure		

Table 4.10: Switch ‘Close-Open’ VCB Activity versus Contact with Live Electrical Equipment.

Job Step		Switch ‘close-open’ VCB activity.
Hazard		Contact with live electrical equipment.
Consequences		1. Possibility of electrocution/electric equipment. 2. Fatality.
Existing Control Measure (ECM).		1. Supervision by competent person 33/11kV. 2. Use proper PPE. 3. Available rubber mats.
Risk Assessment	**Likelihood**	L
	Severity	H
Risk Level		M
Further Control Measure		

Table 4.11: Switch ‘Close-Open’ VCB Activity versus Postural.

Job Step		Switch ‘close’ or ‘open’ VCB activity.
Hazard		1. Standing too long. 2. Repetitive movement.
Consequences		1. Fatigue. 2. Back pain. 3. Neck and shoulder disorder.
Existing Control Measure (ECM)		
Risk Assessment	**Likelihood**	L
	Severity	M
Risk Level		M
Further Control Measure		1. Survey assessment.

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Table: 4.12: 'Rack-In' or 'Rack-Out' VCB Activity versus Contact with Live Electrical Equipment.

Job Step		'Rack-in' or 'rack-out' VCB activity.
Hazard		Contact with live electrical equipment.
Consequences		1. Possibility of electrocution/electric shock. 2. Fatality.
Existing Control Measure (ECM)		1. Supervision by competent person 33/11kV. 2. Use proper PPE. 3. Available rubber mats. 4. Available buddy system.
Risk Assessment	**Likelihood**	L
	Severity	H
Risk Level		M
Further Control Measure		

Table 4.13: 'Rack-In' or 'Rack-Out' VCB Activity versus Hazards.

Job Step		Rack-in' or 'rack-out' VCB activity.
Hazard		1. Manual handling and heavily equipment. 2. Awkward posture. 3. Standing too long.
Consequences		1. Fatigue. 2. Back pain. 3. Neck and shoulder disorder.
Existing Control Measure (ECM)		
Risk Assessment	**Likelihood**	L
	Severity	M
Risk Level		M
Further Control Measure		1. Survey assessment.

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Table 4.14: ‘Rack-In’ or ‘Rack-Out’ VCB Activity versus No Labelling.

Job Step		Rack-in’ or ‘rack-out’ VCB activity.
Hazard		No labelling.
Consequences		1. Misalignment due to ‘rack-in’ or ‘rack-out’ VCB activity. 2. Electric flashover. 3. Fatality.
Existing Control Measure (ECM)		1. Supervision by competent person 33/11kV. 2. Use proper PPE. 3. Available rubber mats. 4. Available buddy system.
Risk Assessment	**Likelihood**	L
	Severity	H
Risk Level		M
Further Control Measure		1. Put number labelling each VCB for each HT feeder.

Table 4.15: VCB Servicing versus Power Tools.

Job Step		VCB servicing.
Hazard		Power tools.
Consequences		1. Carpal tunnel syndrome. 2. Numbness. 3. Tingling. 4. Injuries.
Existing Control Measure (ECM)		
Risk Assessment	**Likelihood**	L
	Severity	M
Risk Level		M
Further Control Measure		1. Survey assessment. 2. Job rotation.

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Table 4.16: VCB Servicing versus Hazard Postural.

Job Step		VCB servicing.
Hazard		Awkward posture and repetitive movement.
Consequences		1. Fatigue. 2. Back pain. 3. Neck and shoulder disorder.
Existing Control Measure (ECM)		
Risk Assessment	**Likelihood**	L
	Severity	M
Risk Level		M
Further Control Measure		1. Survey assessment. 2. Job rotation.

Table 4.17: Lock Shutter versus Contact Live Electrical Equipment.

Job Step		Lock shutter.
Hazard		Contact live electrical equipment.
Consequences		1. Possibility of electrocution/electric shock. 2. Fatality
Existing Control Measure (ECM)		1. Supervision by competent person 33/11kV 2. Use proper PPE 3. Available rubber mats. 4. Available buddy system.
Risk Assessment	**Likelihood**	L
	Severity	H
Risk Level		M
Further Control Measure		

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Table 4.18: Lock Shutter versus Postural.

<table>
<tr><td colspan="2">Job Step</td><td>Lock shutter.</td></tr>
<tr><td colspan="2">Hazard</td><td>Awkward posture.</td></tr>
<tr><td colspan="2">Consequences</td><td>1. Fatigue.
2. Back pain.
3. Neck disorder.</td></tr>
<tr><td colspan="2">Existing Control Measure (ECM)</td><td></td></tr>
<tr><td rowspan="2">Risk Assessment</td><td>Likelihood</td><td>L</td></tr>
<tr><td>Severity</td><td>M</td></tr>
<tr><td colspan="2">Risk Level</td><td>M</td></tr>
<tr><td colspan="2">Further Control Measure</td><td>1. Survey assessment.</td></tr>
</table>

Table 4.19: Proof Circuit Dead versus Contact Live Electrical Equipment.

<table>
<tr><td colspan="2">Job Step</td><td>Proof Circuit Dead (PCD).</td></tr>
<tr><td colspan="2">Hazard</td><td>Contact live electrical equipment.</td></tr>
<tr><td colspan="2">Consequences</td><td>1. Possibility of electrocution/electric shock.
2. Fatality.</td></tr>
<tr><td colspan="2">Existing Control Measure (ECM)</td><td>1. Supervision by competent person 33/11kV.
2. Use proper PPE.
3. Available rubber mats.</td></tr>
<tr><td rowspan="2">Risk Assessment</td><td>Likelihood</td><td>L</td></tr>
<tr><td>Severity</td><td>H</td></tr>
<tr><td colspan="2">Risk Level</td><td>M</td></tr>
<tr><td colspan="2">Further Control Measure</td><td></td></tr>
</table>

Table 4.20: Proof Circuit Dead versus Postural.

<table>
<tr><td colspan="2">Job Step</td><td>Proof Circuit Dead (PCD).</td></tr>
<tr><td colspan="2">Hazard</td><td>Awkward posture.</td></tr>
<tr><td colspan="2">Consequences</td><td>1. Back pain.
2. Neck and shoulder disorder.</td></tr>
<tr><td colspan="2">Existing Control Measure (ECM)</td><td></td></tr>
<tr><td rowspan="2">Risk Assessment</td><td>Likelihood</td><td>L</td></tr>
<tr><td>Severity</td><td>M</td></tr>
<tr><td colspan="2">Risk Level</td><td>M</td></tr>
<tr><td colspan="2">Further Control Measure</td><td>1. Survey assessment.</td></tr>
</table>

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Table 4.21: Lock Compartment versus Postural.

Job Step		Lock compartment.
Hazard		1. Awkward posture. 2. Repetitive movement.
Consequences		1. Back pain. 2. Neck and shoulder disorder.
Existing Control Measure (ECM)		
Risk Assessment	**Likelihood**	L
	Severity	M
Risk Level		M
Further Control Measure		1. Survey assessment.

Table 4.22: General Cleaning and Housekeeping versus Postural.

Job Step		General cleaning and housekeeping.
Hazard		1. Awkward posture. 2. Repetitive movement.
Consequences		1. Back pain. 2. Neck and shoulder disorder.
Existing Control Measure (ECM)		
Risk Assessment	**Likelihood**	L
	Severity	M
Risk Level		M
Further Control Measure		1. Survey assessment.

From the HIRAC assessment, the risk can be measured using risk category matrix following Risk Matrix Table (Table 4.23), safety issues related voltage installation work.

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Table 4.23: Risk Matrix

Severity / Likelihood		H	M	L
		H^A	M^A	L^A
H	H^B	**VH**	**H**	**M**
M	M^B	**H**	**H**	**M**
L	L^B	**M**	**M**	**L**

Legend: VH (Very High)
H (High)
M (Medium).
L (Low)
OI = Occupational health.
LTI = Lost time Injuries.
PD= Property damage.
CM= Control measure.
MC= Medical leave.
CA and PA: Corrective action and Preventive action.
H^A = Fatality or Permanent disablement or chronic or irreversible OI; i.e: cancer, deaf, leukemia, slipped disc. **(MC>1 Shift or 1 Day)** or **PD>RM100, 000.**
M^A = LTI due to **MC or OI (1 Shift or 1 Day)** or **RM 10,000<PD<RM100, 000.**
L^A = Minor injuries or first aid cases or medical treatment cases, Minor OI **(no MC)** or **PD<RM10, 000.**
H^B = Has happened in past and CA and PA not taken or not fully.
M^B = Likely to happen due to no CM or inadequate CM.
L^B = Unlikely to happen due to adequate CM or has happened in the past and CA and PA is effective.

From the result on HIRAC assessment on safety issues related voltage installation on switching HT among respondents, job step with the lowest hazard and risk were 'pre-start work' and 'enter the working area' in which the hazards were 'lack of knowledge of the work and surrounding risk' and 'less air fresh'. Rating of risk assessment for likelihood and severity was low, existing control measure (ECM) for less fresh air was using portable jet fan which is suction air fresh from outside to provide enough fresh air to working area.

From table 4.1 until table 4.22 shows all job steps from pre-start work until general cleaning and housekeeping have low indication for risk assessment under likelihood but for severity they have different indications.

From table 4.5, 4.7, 4.9, 4.10, 4.12, 4.14, 4.17 and 4.19 shows high indication on severity risk assessment, most of the hazards were related with electrical work in which consequences were fatality possibility of electrocution or electric shock. Therefore, for high severity, existing control measure will be supervised by competent chargeman 33/11KV and electrical protection equipment will be provided following Electrical Supply Act.

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From table 4.3, 4.6, 4.8, 4.11, 4.13, 4.15, 4.16, 4.18, 4.20, 4.21 and 4.22 shows that medium severity, most of the hazards were associated with postural movements which led to musculoskeletal disorders and there was no existing control measure. Therefore, there was a need to evaluate musculoskeletal disorder on job step at Phase 2.

4.3 Phase 2: Musculoskeletal Disorder Assessment Results

For this topic, results of musculoskeletal disorder assessment regarding postural during voltage installation work on switching HT were discussed. It can be determined by analyses using Rapid Upper Limb Body Assessment (RULA), Rapid Entire Body Assessment (REBA) and Nordic Musculoskeletal Disorder Questionnaire (NMDQ).

4.3.1 Rapid Upper Limb Assessment (RULA)

RULA (Rapid Upper Limb Assessment) is a study technique created for use in ergonomics assessment of working environments where work related upper limb disorder are revealed. This instrument requires no exceptional equipment in giving an evaluation of the posture of the neck, trunk and upper limbs alongside muscle-work and the outer burdens experienced by the body. A coding system is utilized to produce an activity list which shows the level of intercession required to lessen the risk of damage due to physical stacking on the workers (McAtamney, et al, 1993). Table 4.24 shows RULA score and action required to indicate risk level from the posture of the voltage installation work on switching HT task among respondents.

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Table 4.24: RULA Score (McAtamney, et al, 1993).

SCORE	ACTION REQUIRE
1 - 2	Acceptable posture
3 - 4	Further investigation, change may be needed
5 - 6	Further investigation, change soon
7	Investigate and implement change

Twenty respondents were selected for this assessment and screening for posture during work and he results of RULA assessment were as shown in Table 4.25.

Table 4.25: Distribution of RULA Score of Switching HT.

RULA score	Action require	No. of worker	% of workers
1 - 2	Acceptable posture	0	0
3 - 4	Further investigation, change may be needed	3	15
5 - 6	Further investigation, change soon	2	10
7	Investigate and implement change	15	75

N= 20 respondents

From the feedbacks, RULA assessment among maintenance workers and competent chargeman on voltage installation work found that the score for 'switch 'close' or 'open' VBC activity and lock shutter, and 'only competent chargeman can operate it' was 3, 2 persons from maintenance team lock compartment scored 4 in which it required further investigation, change may be needed. Total respondents for this rating who scored 3 – 4 was 3 (15%).

From table 4.26, job step 'visual inspection', 2 respondents scored 6 that it required further investigation, change soon. Total respondent who scored 5 – 6 was 2 workers (10%). For RULA rating scored 7, many job steps were involved: VCB servicing 7 workers from

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maintenance team carried out this job, general cleaning and housekeeping involved 3 workers, check relay protection status involved 4 workers, step Earth switch ‘close’ or ‘open’, Proof Circuit Dead (PCD) and ‘rack-in’ or ‘rack-out’ VCB activity involved 1 workers which is competent chargeman and total workers involved was 15 (75%). Table 4.26 shows RULA scores of job steps and total numbers of respondents.

Table 4.26: RULA Score of Switching HT.

Job Step	**RULA score**				**No. of workers**
	1 – 2	3 – 4	5 – 6	7	
Switch ‘close’ or ‘open’ VCB activity		1			1
Lock shutter		1			1
Lock compartment		2			2
Visual inspection			2		2
VCB servicing				7	7
General cleaning and housekeeping				3	3
Check relay protection status				4	4
Earth switch ‘close’ or ‘open’				1	1
Proof Circuit Dead (PCD)				1	1
‘Rack-in’ or ‘rack-out’ VCB activity				1	1

From RULA score, voltage installation work was scored 7 (75%). VCB servicing, general cleaning and housekeeping, check relay protection status, earth switch ‘close’ or ‘open’, proof circuit dead and ‘rack-in’ or ‘rack-out’ VCB activities needed to be investigated and implemented change, where management must find some new ways to reduce RULA score for those job steps to prevent workers of engineering Department from minor or major injuries on musculoskeletal disorder that effect performance of individual and company.

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4.3.2 Rapid Entire Body Assessment (REBA)

Rapid Entire Body Assessment (REBA) was created to evaluate the sort of erratic working posture found in health services and other service industry. Information gathered was about the body posture, forces during work, sort of development or activity, awkward posture, repetition, and coupling. A last REBA score was produced to provide a sign of hazard level and earnestness with which move ought to be made (L. McAtamney, 2002). Table 4.27 shows REBA score and action required, followed by assessment by maintenance workers and competent chargeman.

Table 4.27: REBA Scores (L. McAtamney, 2002).

SCORE	ACTION REQUIRE
1	Negligible
2 – 3	Low risk, further investigate, change soon
4 – 7	Medium risk, further investigate, change soon
8 – 10	High risk, investigate and implement change
11 AND ABOVE	Very high risk, implement change

From assessment of switching HT on 20 respondents, it can measure REBA score from their feedback. Table 4.28 shows distribution numbers of total workers' scores and action required for betterment.

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Table 4.28: Distribution of REBA score for switching HT.

Score	Action require	No. of workers	% of workers
1	Negligible	0	0
2 – 3	Low risk, further investigate, change soon	3	15
4 – 7	Medium risk, further investigate, change soon	6	45
8 – 10	High risk, investigate and implement change	5	25
11 and above.	Very high risk, implement change	6	45

N = 20 respondents.

From analysis REBA on working posture on voltage installation (refer on table 4.28 and table 4.29), the low risk which is REBA score is 2, job step ‘visual inspection’ was involved 2 maintenance workers and REBA score is 3,job step switching ‘‘close’ or ‘ open’ VCB activity’ only competent chargeman can operate this job. REBA score 4, job step ‘lock compartment’ 2 maintenance workers involved and job step ‘check relay protection’ status 3 maintenance workers involved. For REBA score is 6, job step is ‘lock shutter’ and REBA score is 7, job step ‘proof circuit dead’ only can operate this 2 job step is competent chargeman. REBA score 9, 4 maintenance workers were involved under job step ‘general cleaning and housekeeping’ and for REBA score 10 competent chargeman was involve this job step which is ‘‘rack-in’ or ‘rack-out’ VCB activity’ and earth switch ‘close’ or ‘open’. For REBA score 11, 6 maintenance workers involved under job step ‘VCB servicing’. Those data analysis tabulation on table 4.29.

Table 4.29: REBA Scores of Job Step.

Job steps	**REBA Score**					**Number of workers**
	1	**2 – 3**	**4 – 7**	**8 – 10**	**11**	
Visual Inspection		2				2
Switching 'close' or 'open' VCB activity		1				1
Lock compartment			2			2
Checks relay protection status			3			3
Lock shutter			1			1
Proof Circuit Dead			1			1
General cleaning and housekeeping				4		4
'Rack-in' or 'Rack-out' VCB activity				1		1
Earth switch 'close' or 'open'.				1		1
VCB servicing.					6	6

From Table 4.28, 45% of workers were exposed to medium and very high risks. Management should be considering taking immediate actions especially for VCB servicing. Table 4.30 shows comparison of RULA and REBA risk level.

Table 4.30: Comparison of RULA and REBA Risk Levels.

Assessment Tool	**Percentage of workers (%)**				
	Acceptable	Low risk	Medium risk	High risk	Very high risk
RULA	0	15	10	75	0
REBA	0	15	45	25	45

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From Table 4.30, working on voltage installation was in high risk for body posture. It needs immediate action and changes must be implemented at workplace. Management should acknowledge and analyze the best solution to reduce the risk level using control measure analysis.

4.3.3 Nordic Musculoskeletal Disorder Questionnaire

Nordic musculoskeletal disorder questionnaire was distributed to evaluate risk level on musculoskeletal disorder during voltage installation work. Table 4.31 shows basic demographic information of respondents.

Table: 4.31: Demographic Information.

Variable	**Description**	**Frequency**	**Percentage (%)**
Gender	Male	20	100
	Female	0	0
Age	20 years – 30 years	8	40
	31 years – 40 years	8	40
	41 years – 50 years	4	20
	51 years and above	0	0
Body mass index	Underweight = <18.5	0	0
	Normal weight = 18.5–24.9	10	50
	Overweight = 25–29.9	9	45
	Obesity = BMI of 30 or greater	1	5
Employment period	< 2 years	0	0
	2 years and above	20	100
Working hours/Day	8 hours (Normal)	10	50
	12 hours (Shift)	10	50

From the Table 4.31, eight male workers worked on voltage installation and range of their age was between 20 years and 30 years and 31 years – 40 years respectively. Body Mass Index (BMI) is a person's weight in kilograms divided by the square of height in meters. A high BMI can be a marker of high body fatness. BMI can be utilized to screen for weight

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classifications that may prompt medical issues yet it is not symptomatic of the body fatness or strength of a person (Garrouste-Orgeas, et al., 2004). In this study, body mass index have 4 categories; 10 workers have normal weight index which was in a range between 18.9 and 24.9, 9 workers were overweight (BMI 25 – 29.9) and 1 worker was an obese (BMI 30 and above). That meant overall respondents were fit for the jobs with normal weights. All respondents experienced working more than 2 years and have balance working hours per day which 10 workers worked on normal shift (8 hours) and another 10 workers worked on shift (12 hours).

Table 4.32: Demographic Of Job Steps.

Variable	Description	Frequency	Percentage (%)
Job steps	Visual inspection	19	19
	Checks relay protection status	13	13
	Switch 'close' or 'open' VCB activity	2	2
	'Rack-in' or 'rack-out' VCB activity	2	2
	VCB servicing	20	20
	Lock shutter	2	2
	Proof circuit dead	2	2
	Earth switch 'close' or 'open'	3	3
	Lock compartment	18	18
	Cleaning and housekeeping	19	19

Table 4.32 shows that one worker did not only do 1 job step but minimum job steps per 1 worker were 3 job steps. The highest frequency was for VCB servicing followed by visual inspection and cleaning and housekeeping. The lower frequencies were for job steps: switch 'close' or 'open' VCB activity, 'rack-in' or 'rack-out' VCB activity, lock shutter, proof circuit dead and lock shutter, because these jobs step only can be operated by a competent chargeman following legislation in Malaysia.

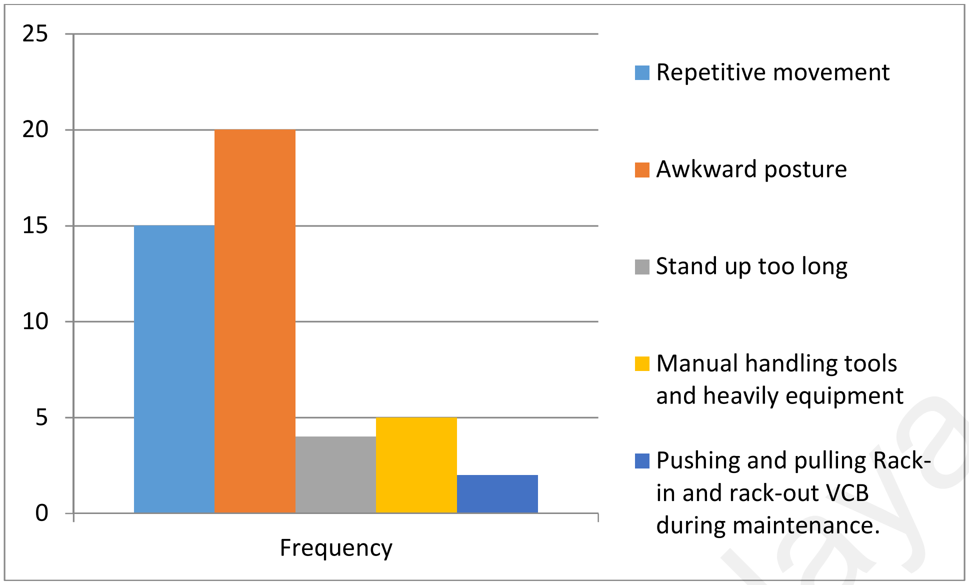

Figure 4.1: Cause of the Occurrence of Pain in Voltage Installation Work.

Graphs in Figure 4.1 refer to respondents' feedback during and after they were performing work voltage installation work. Randomly, 1 respondent has more than 1 work posture effect due to this job. Awkward posture was the highest posture cause disorder during voltage installation work, followed by repetitive movement, manual handling tools and heavily equipment, stand up too long and pushing and pulling rack-in and rack-out VCB during maintenance because only competent chargeman can rack-in or rack-out VCB activity. The disorder can be reduced by applying job rotation in which workers who have symptom disorder on awkward posture can adjust job circle to minimize repetitive awkward posture.

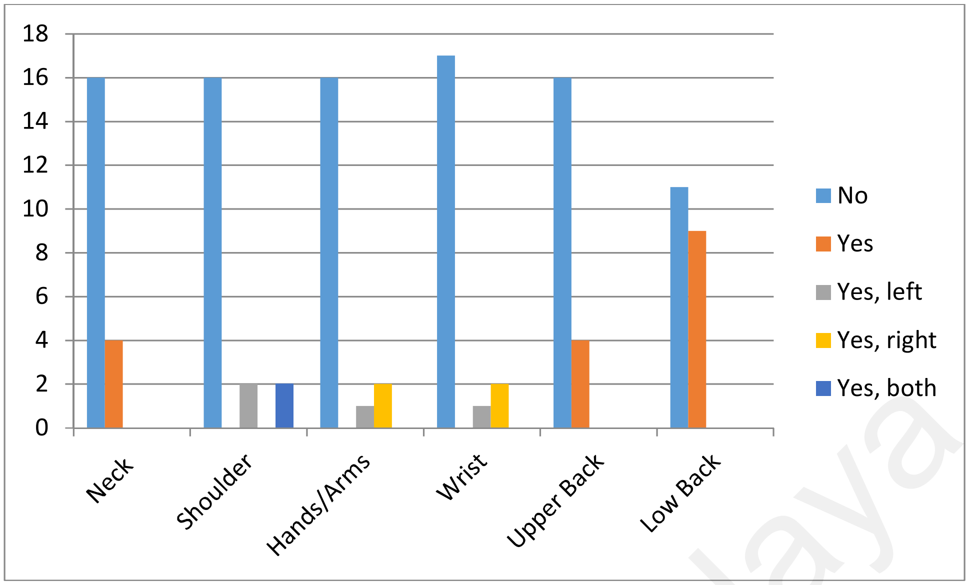

Figure 4.2: Prevalence 12 Months Musculoskeletal Disorders.

Figure 4.2 shows graphs about respondents within 12 months of experiencing disorder (pain, numbness, tingling, uncomforting). Many respondents responded 'no' and at same time they responded that they got disorders for certain part of musculoskeletal system. Low back pains was the highest disorder (9 frequencies), followed by upper back and neck pain (4 frequencies) and right hands/arms, wrist pain and left shoulder and both shoulder pain (2 frequencies). Hands/arms and wrist pains were only 1 frequency. Factor respondent response the highest on low back and then followed by upper back and neck because an age factor and jobs step of VCB servicing and general cleaning and housekeeping which is more on repetitive movement and awkward posture.

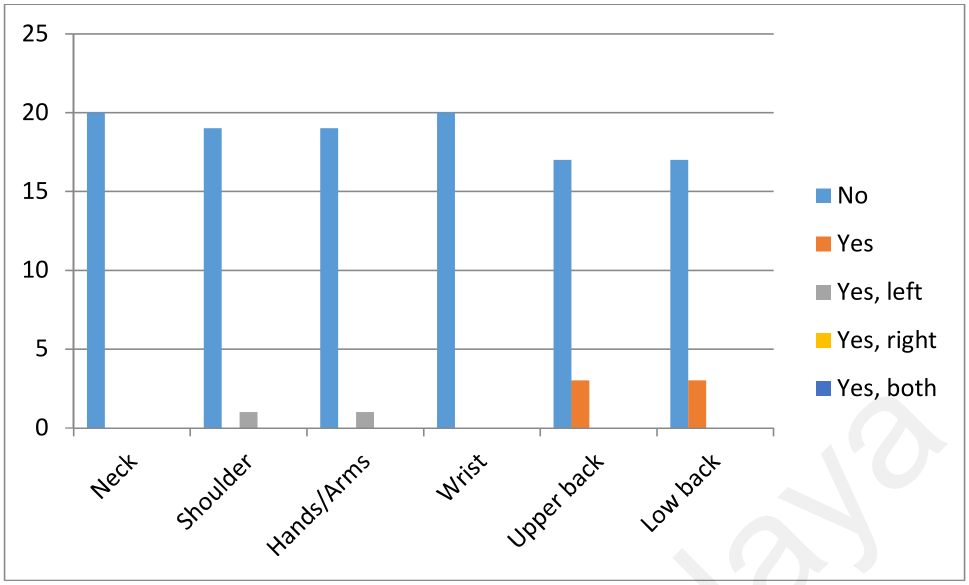

Figure 4.3: Injuries in Work Place

From the graph in Figure 4.3, most respondents gave 'no' feedback that mean during working on voltage installation, less injuries were experienced by respondents; 3 cases for upper back and low back and 1 case for left shoulder and hands/arms. From this, it can be confirmed that maintenance workers and competent chargeman were working in safety condition and were alert that the work can cause major injuries. The age factor one of causes contribute injuries on low back and upper back during work task.

A reasonable refinement ought to be made between the nearness of symptoms, the detailing of low back pain, ascribing symptoms to work, announcing 'injury', looking for medicinal services, loss of time from work and long-term harm. Low back pain in the word related setting must be seen against the high foundation predominance and repeat rates of low back symptoms, and to a lesser degree incapacity, among the grown-up populace. Workers in substantial manual occupations do report rather increasingly low back side effects, however a great many people in lighter jobs or even the individuals who are not working have comparative indications. Jobs with more prominent physical requests ordinarily have a higher rate of reported low back symptoms, however the vast majority of these 'injuries' are identified with typical regular exercises, for example, bending and lifting, there is nearly nothing if any target proof of tissue harm (however clinical examination and current in vivo examinations might be heartless apparatuses to distinguish this), and the connection between occupation requests and indications or damage rates is conflicting. Physical stressors may over-burden certain structures in individual cases, in any case, when all is said in done, there is little proof that physical stacking in present day work causes lasting harm. Regardless of whether low back side effects are credited to work, are accounted for as 'wounds', lead to medicinal services chasing as well as result in time off work relies upon complex individual psychosocial and work hierarchical variables (Waddell, G., 2001).

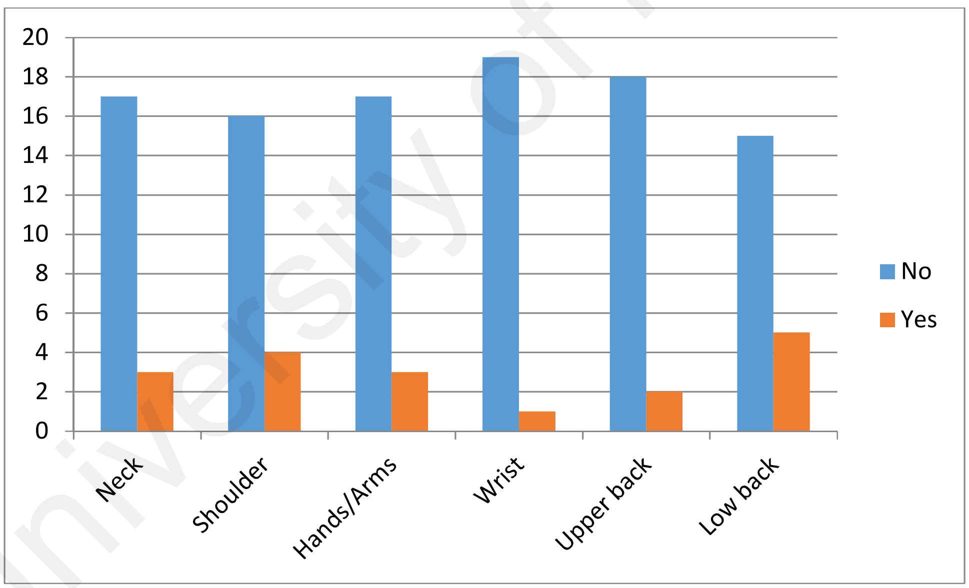

Figure 4.4: Musculoskeletal Disorder in Routine Work in 12 Months.

Figure 4.4 shows that respondents experience disorders on routine work at home or outside home within 12 months. In terms of frequency, 3 respondents gave feedback that they have neck pain, 4 respondents have shoulder pain, 3 respondents have hands/arms pain, 1 respondent has wrist pain, 2 respondents have upper back pain and the highest feedback was regarding low back by 5 respondents. Most respondents' response work in repetitive

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movement and awkward posture contribute highest in low back and follow by shoulder. That meant they must work in job rotation during routine work on a regular basis to minimize their pain especially low back and shoulder pains.

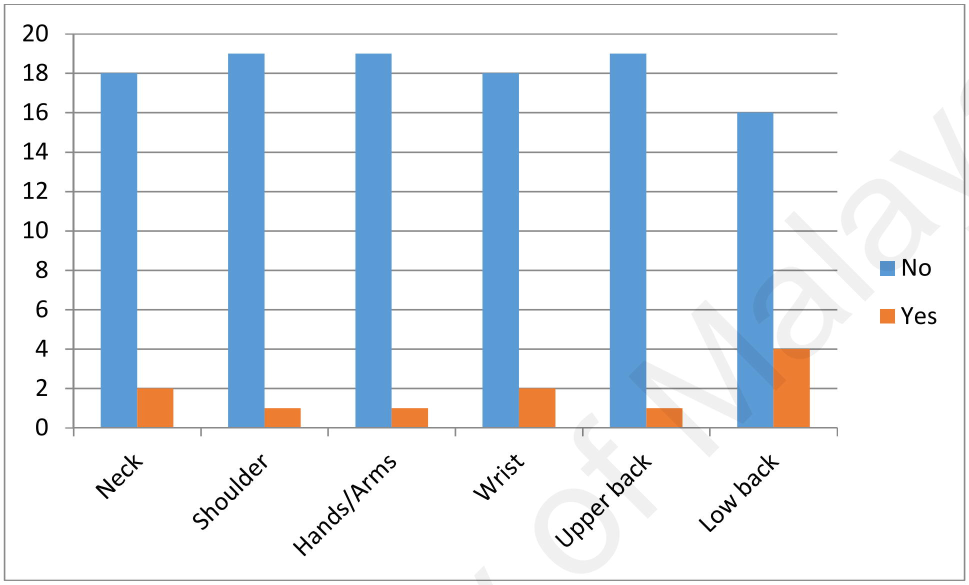

Figure 4.5: Disorders within Last 7 Days

From the graphs in Figure 4.5, two respondents gave feedback that they have neck pain and wrist, 1 respondent has shoulder pain, hands/arms and upper back and 4 respondents have low back pain. From that fact, the researcher assumed that workers experienced low back disorders due to job step and age factors that by referring to Table 4.31, 4 respondents were on average age of 41 years – 50 years. The age factor one of contribute low back pain also most of work is job step 'VCB servicing' with is highest respondents' respond its where high risk in RULA score and very high risk in REBA scores.

Low back, the primary biomechanical risk factors distinguished for the improvement of low back work-related MSD were substantial physical work, awkward static and dynamic working postures, and lifting. The psychosocial chance variables distinguished were negative affectivity, low dimension of job control, physiological demands and high work disappointment. Individual risk factors recognized were more youthful age, female gender, smoking, high BMI, and co-horribleness. Neck, the biomechanical risk factors recognized for the improvement of neck work-related MSD were substantial physical work, awkward postures, and regular lifting. The psychosocial risk factors distinguished were low level of work fulfillment and support, and abnormal state of misery. Individual risk factors recognized were more seasoned age, female gender, and inactive way of life, high BMI, co-grimness, and smoking. Wrist/hand. The biomechanical risk factor recognized for the advancement of wrist/hand work-related MSD including carpal tunnel disorder were overwhelming physical work, awkward static and dynamic working postures, repetitive work, and delayed PC work. The psychosocial risk factor recognized was abnormal state of misery. Individual risk factors recognized were older age, female gender, smoking, high BMI, and co-dreariness (Da Costa, et al., 2009).

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CHAPTER 5: CONCLUSION AND RECOMMENDATION

5.1 Conclusion

In conclusion, it was basic that before enabling work on voltage installation to begin, those in control ought to recognize the hazards, the risk by the hazards and the control measure expected to decrease the risks to guarantee protected and dependable tasks. The workers used HIRAC to determine and analysis safety issues related with voltage installation work and adopt HIRAC as a safety tool when performing tasks. It is important to ensure workers following requirement act and regulation by Energy Commissioner during voltage installation because without supervision by competent chargeman and other safety equipment like rubber mats, buddy system and fire alarm system at workplace, accident, fatality or major injuries could happen because flashover temperature from arc flash is high.

In additional, workers were confirmed in high risk and very high risk from RULA and REBA analyses on a voltage installation work. For RULA and REBA, job steps of VCB servicing were high and very high risks that needed to implement changes to reduce the risks. Example, job rotation among maintenance workers and reduce working period for VCB servicing. Working in awkward posture, repetitive posture and low back pain were the most significant result analysis among respondents. The risk of low back can be reduced by delivering sufficient knowledge like attending human factor and ergonomic training, designing lifting tasks, aware of good handling techniques like planning and preparation, foot positioning, gripping, lifting, moving the load and lowering the load first and before adjusting. Therefore, they can prevent workers from musculoskeletal disorder and also reduce medical cost due to related disorder. Company's revenue will increase when workers work in a healthy condition.

5.2 Recommendations

Based on result and discussion, some recommendations on voltage installation work related with safety issues and musculoskeletal disorder among maintenance workers and competent chargeman. They were elaborated below:

5.2.1 Engineering Control

For task voltage installation related with safety issues during 'rack in' and 'rack out' breaker, maintenance team and chargeman utilized RIRO (Rack-In Rack-Out) equipment, operated by automation system for rack in and rack out breaker to ensure flashover to human and equipment can be reduced. For musculoskeletal disorder, workstation layouts and designs were to ensure workers comfortably perform jobs, included:

1. Portable ladder for easier working at height.
2. Design adjustable chair up and down following VCB height to avoid working in awkward posture and repetitive movement. Workers can sit on a chair while doing VCB servicing.

5.2.2 Administration Control

For voltage installation related with safety issues, buddy system can be implemented to reduce error during job steps. Supervision by competent chargeman 33/11KV was to ensure maintenance workers worked under monitoring to prevent fatality or electrocute during voltage installation task.

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For musculoskeletal disorder, job rotation for each worker can be implemented to reduce disorder during works. Besides, workers can alternate work and do short stretching to prevent disorder and fatigue during work.

5.2.3 Personal Protective Equipment (PPE)

While working on voltage installation for switching, the competent chargeman used fire retardant suit for electrical switching with arc rating 40 which was suitable for switching high voltage 11KV and above. Maintenance workers used face mask, glove and coverall clothes when working on voltage installation.

To prevent disorder, workers must wear ergonomic PPE, example, padding gloves to prevent carpal tunnel syndrome and wear lightweight coverall and fire retardants suit to prevent neck and shoulder pain. Workers also should wear spine protection corset to prevent upper back pain and lower back pain.

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